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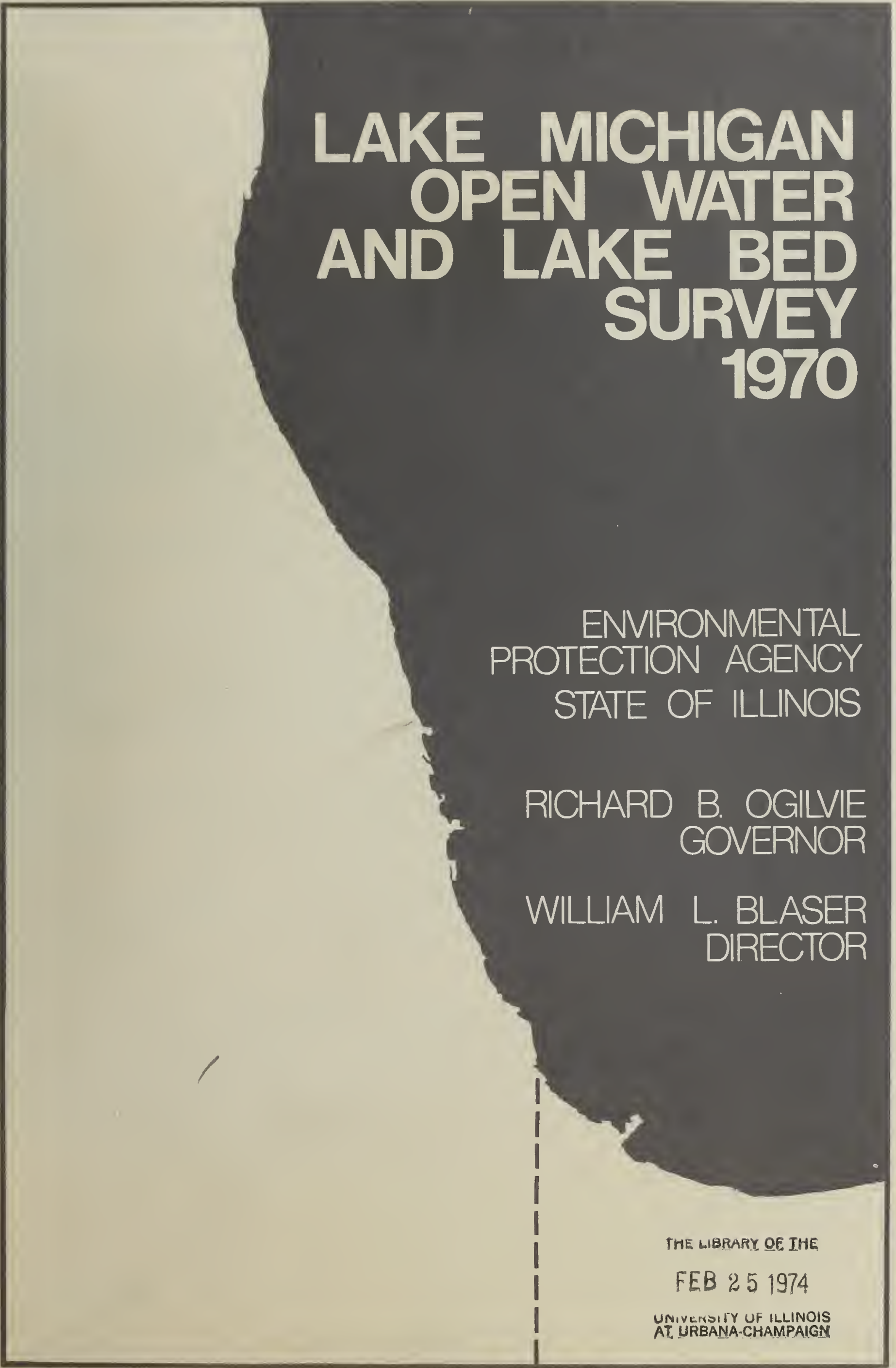

LAKE MICHIGAN OPEN WATER AND LAKE BED SURVEY
1970

ENVIRONMENTAL
PROTECTION AGENCY
STATE OF ILLINOIS

RICHARD B. OGILVIE
GOVERNOR

WILLIAM L. BLASER
DIRECTOR

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ENVIRONMENTAL PROTECTION AGENCY • STATE OF ILLINOIS
William L. Blaser, Director • Richard B. Ogilvie, Governor

The Honorable Richard B. Ogilvie
Governor, State of Illinois

Honorable Members of the 77th
General Assembly, State of Illinois

Gentlemen:

The Illinois Environmental Protection Agency presents a report of the results of Lake Michigan open water and lake bed surveys conducted during 1970.

These surveys, to evaluate the ecology and the quality of the open water of Lake Michigan, were authorized initially by the 75th General Assembly. The responsibility for these surveys was assumed from the Sanitary Water Board by the Environmental Protection Agency under provisions of the Environmental Protection Act, passed by the 76th General Assembly and signed into law by Governor Ogilvie effective July 1, 1970.

Data obtained during the 1970 surveys are presented in this report, along with an evaluation of the present quality of Lake Michigan open water.

Dramatic improvements over short periods of time are improbable with large bodies of water such as Lake Michigan. It is, however, possible to observe changes in various water quality measurements from year to year. Data from 1968-70 suggests there has been slight improvement in the quality of Lake Michigan open water. The abstract on page iv summarizes these changes.

Lake bed sampling during 1970 indicated that slightly more than half of the stations sampled were "ecologically degraded." The same was true in 1969.

Action by Illinois municipalities and industries to control waste discharges into Lake Michigan eventually will determine the state's ability to comply with appropriate water quality standards. A summary of such action to date is presented in this report.

It is clear that the State of Illinois must maintain a continuing program of surveillance and monitoring, first, to evaluate changes in dymanics which may affect the economic and aesthetic values of Lake Michigan; and, second, to assess the effectiveness of measures taken by Illinois and other states to control or eliminate the pollution of Lake Michigan.

Sincerely,

William L. Blaser
Director

WLB:sam

2200 Churchill Road • Springfield, Illinois 62706 • Telephone: 217-525-3397

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ABSTRACT

OPEN WATER QUALITY AND LAKE BED SURVEY

Open water samples were collected from the municipal water filtration plants monthly in the first and last quarters of 1970; bi-weekly samples were collected from April through September. Additional samples were collected during ten water quality ship cruises. Bottom dredge samples were obtained at sixty stations on twenty-three ship dredging cruises. The results of the water plant sampling are summarized below. Note: Data for Dissolved Oxygen and Bottom Deposits were obtained during offshore ship sampling.

Results of biological, chemical and bacteriological analyses were compared to the Water Quality Standards, Rules and Regulations SWB-7.

A comparison of the water quality data obtained from the water plants and offshore ship sampling indicated generally lower values in the offshore waters, which is indicative of better water quality in the open waters removed from near shore influences. Water plant values exceeded the standards for Total Phosphates, MBAS and Chlorides. In the open waters, only the Total Phosphate standard was exceeded. Of the twenty-one water quality parameters for which data were obtained, seventeen complied with the applicable standards in 1970 and four exceeded the established limits as indicated below:

COLIFORM AND FECAL STREPTOCOCCI - bacterial counts were within the standards. For both parameters, there was a continuing decrease from 1968 to 1970.

ODOR, OIL, FLOATING SOLIDS AND DEBRIS - were within the standards. No significant change occurred from 1968 to 1970.

DISSOLVED IRON AND SULFATE - concentrations were within the standards. During the three year period 1968-1970, there was a continuing decrease in dissolved iron and sulfate concentrations.

FLUORIDE, CYANIDE, pH, PHENOLS AND RADIOACTIVITY - levels were within the standards. Little significant change occurred from 1968 through 1970.

DISSOLVED OXYGEN - saturation levels were within the standards. Little significant change occurred from 1969 to 1970 (data not available for 1968).

AMMONIA NITROGEN AND FILTRABLE RESIDUE - concentrations were within the standards. These concentrations, which exceeded the standards in 1969, decreased to within acceptable levels in 1970.

TURBIDITY AND TEMPERATURE - measurement were within the standards. Turbidity measurements increased slightly from 1968 to 1970.

TOTAL PHOSPHATE - concentrations exceeded the standards. Although values exceeded the standards, there was a continuing decrease in concentrations from 1968 to 1970.

MBAS AND CHLORIDE - concentrations exceeded the standards. These concentrations increased slightly during the 1968-1970 period.

BOTTOM DEPOSITS - 53% of the lake bed stations sampled were considered representative of a degraded environment.

WATER MONITORING PROGRAM

GENERAL INFORMATION

The water monitoring data relates to three areas: (1) Open Water, (2) U.S. Established Dumping Area, and (3) Calumet Harbor. Descriptions of the areas, and of the methods of collection and frequency of sampling are presented in the following sections.

Water Quality Standards for Lake Michigan, Rules and Regulations SWB-7, adopted by the Illinois Sanitary Water Board, served as the basis for evaluation of 1970 monitoring results in the Open Water and U.S. Established Dumping Area sections of this report. Water Quality Standards for Calumet Harbor are included in Rules and Regulations SWB-15.

In 1970 the 76th General Assembly passed the Environmental Protection Act. This Act, H.B. 3788, approved on June 29, 1970, became effective July 1, 1970. The Act created the Environmental Protection Agency which replaced the Sanitary Water Board. The Act provided that all the applicable rules and regulations adopted by the Sanitary Water Board shall remain in full force and effect until repealed, amended or superseded by the Pollution Control Board, also established by the Environmental Protection Act.

Surveillance personnel in the Division of Water Pollution Control, Illinois Environmental Protection Agency, collected the samples. Water samples were delivered to the Chicago Branch Laboratory of the Agency for chemical and bacteriological analyses. In warm weather months, samples were kept in iced containers during delivery to the laboratory. The Division of Waterways, Illinois Department of Public Works and Buildings, provided a ship for lake bed and offshore water quality sampling.

OPEN WATER

The raw water intakes at the municipal water filtration plants which utilize Lake Michigan as their source of water supply have been designated in SWB-7 as the control points for monitoring the quality of Lake Michigan open waters. In 1968 twelve water plants were sampled. The Great Lakes Naval Training Center and the Northbrook plants were dropped in 1969 and 1970. In 1969 only the Waukegan, North Chicago, Highland Park, Evanston, and Chicago South water plants were monitored.

Ten water plants were selected for the 1970 monitoring program, namely: Waukegan, North Chicago, Lake Forest, Highland Park, Glencoe, Winnetka, Kenilworth, Wilmette, Evanston and Chicago South. Samples of water from the raw water intakes at these plants were scheduled for collection twice a month from April through October, and monthly the remainder of the year. Information on intakes at these plants is presented in Table 1.

Water quality data available from the five water plants involved in the 1969 sampling program were evaluated to determine trends during 1968-1970. These five plants are designated as Group A plants in this report.

Water quality data are summarized in Tables 2 through 17.

TABLE 1. WATER FILTRATION PLANTS SAMPLED IN 1970

Name of Plant	No. of Intakes	Distance of Intake From Shore (ft.)	Depth Drawn From (ft.)
1. Waukegan	2	Shore	--
		6,200	35
2. North Chicago	1	6,500	28
3. Lake Forest	2	3,900	24
		6,500	30
4. Highland Park	3	1,000	18
		2,000	18
		3,500	10
5. Glencoe	2	2,000	25
		3,300	18
6. Winnetka	2	1,200	20
		3,000	15
7. Kenilworth	1	2,100	20
8. Wilmette	1	3,300	19
9. Evanston	3	1,800	16
		2,600	18
		5,600	28
10. Chicago South	2	Shore	--
		13,000	32

In addition, ten ship sampling cruises were conducted to obtain open water samples. Samples were collected at a distance of four miles offshore from the following eight locations: Wisconsin-Illinois State Line, Zion, Waukegan, Highland Park, Winnetka, Evanston, Chicago Central Water Filtration Plant and the Chicago South Water Filtration Plant. Samples were also collected at the U.S. Established Dumping Area.

Except for one bottom sample collected at each sampling location, all of the samples were collected at the surface. Due to the limited scope of the bottom sampling, only brief remarks have been made on data obtained from bottom samples.

Water quality data are summarized in Tables 18 through 35.

U.S. ESTABLISHED DUMPING AREA

An area in Lake Michigan has been designated by the United States Government for dumping of non-pollutional harbor dredgings and other material. This area, located approximately ten miles east of the Illinois shore, between Montrose Avenue extended and 74th Street extended, and about five miles wide, is shown in Figure 18. Senate Bill 1794, adopted by the 75th Illinois General Assembly, effective October 30, 1967, prohibits issuance of permits by the Illinois Division of Waterways, for the depositing of rock, earth, sand or other material or any refuse matter of any kind or description in Lake Michigan, except with the concurrence of the Environmental Protection Agency.

Two water sampling trips were made to the dumping area in September and October, 1970. Water samples were collected at six locations. Rules and Regulations SWB-7 Open Water Standards were used to evaluate these data. Only 1970 data on the dumping area is included in this report.

CALUMET HARBOR

Water in Calumet Harbor was sampled during four ship cruises in September, October and November, 1970. Samples were collected at two stations, located at (X) the Illinois-Indiana State Line, and about 20 yards south of the breakwater and at (Y) the mouth of the Calumet River (Figure 23). Only 1970 data on Calumet Harbor is included in this report.

FACTORS INFLUENCING OPEN WATER QUALITY

The monitoring of shore waters reflects the influence of recent input into the lake from both natural and man-made sources. The monitoring of open waters reflects long-term changes resulting from activities and conditions within a major portion of the Lake Michigan watershed.

The term "open water" is a relative term; the farther from shore that a water sample originates, the more representative it becomes of open water.

It should be noted that the intakes of the water plants sampled in 1970 are not all located at the same distances from shore. Normally, along the Illinois shore, mixing between shore waters and offshore waters occurs slowly and to a limited extent. Current velocity gradients and water quality gradients may exist between water plants due to the location of the water intakes within different current and flow patterns.

Industrial wastes and sewage treatment plant effluents discharged to Lake Michigan in the Calumet industrial areas of Indiana and Illinois, and in Lake County, Illinois, affect the quality of Illinois shore water. Additional information with respect to these discharges is presented in the latter portions of this report.

Variations in the water quality with time may reflect changes in lake dynamics occurring at the time of sampling. During most of the year, from about April to November, the lake is thermally stratified due to density differences between the warmer surface waters and the colder deep water layers. An effluent discharged during the period of thermal stratification may take one of several routes within the lake depending upon its density and the prevailing current pattern. Stratification is destroyed during the late fall and spring overturns. There is an apparent increase in the turbidity and mineral content of the open waters during these periods.

RESULTS AND EVALUATION

COLIFORM BACTERIA (Figure 1) (Indicators of contamination, usually by sewage or storm run-off)

Standards: Annual Average (Arithmetic) - not more than 200 per 100 ml
Single Daily Value or Average - not more than 2,500 per 100 ml

Coliform bacteria counts were within the standards at all ten water filtration plants in 1970.

Annual average counts ranged from 4/100 ml at Waukegan to 52/100 ml at North Chicago. The highest single count recorded in 1970 was 900/100 ml.

Comparison data available from the Group A plants for the period 1968-1970 indicate that the coliform bacteria counts decreased in the open water. During this period, the annual average counts decreased from a 1968 high of 215/100 ml to a maximum of 52/100 ml in 1970. Maximum single counts also decreased during this period. In 1968, the highest single count recorded was 2,400/100 ml; this count dropped to 900/100 ml in 1970. The only location where the maximum single value increased from earlier levels was at the North Chicago plant, where the count increased from 280/100 ml in 1969 to 900/100 ml in 1970.

TABLE 2. COLIFORM BACTERIA COUNTS IN LAKE MICHIGAN OPEN WATER, 1970

(Expressed as numbers of bacteria per 100 milliliters)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	1	30	4
North Chicago	1	900	52
Lake Forest	2	150	39
Highland Park	1	180	23
Glencoe	1	40	20
Winnetka	1	270	39
Kenilworth	1	180	40
Wilmette	1	200	39
Evanston	1	90	11
Chicago South	1	76	10
SWB-7 Limits: Not more than		2,500	200

FECAL STREPTOCOCCI (Indicators of recent contamination by sewage)
(Figure 2)

Standard: Not more than 25 per 100 ml

Fecal streptococci counts were in general compliance with the standard in 1970.

During 1970, the standard was exceeded only twice, once each at the Lake Forest and Winnetka plants. The highest count recorded was 40/100 ml at Winnetka.

In the three years from 1968-1970, fecal streptococci counts decreased in the open water. Maximum counts decreased from 120/100 ml in 1968 to 16/100 ml in 1970. During this period, the lowest counts were recorded at the North Chicago and the Chicago South water plants.

TABLE 3. FECAL STREPTOCOCCI COUNTS IN LAKE MICHIGAN OPEN WATER, 1970

(Expressed as numbers of bacteria per 100 milliliters)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	1	10	2
North Chicago	1	1	1
Lake Forest	1	30	3
Highland Park	1	16	3
Glencoe	1	12	2
Winnetka	1	40	4
Kenilworth	1	16	4
Wilmette	1	10	2
Evanston	1	4	1
Chicago South	1	1	1
SWB-7 Limit: Not more than		25	

TURBIDITY
(Figure 3)

Standard: No turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of the water.

Turbidity levels were in general compliance with the standard in 1970.

The annual average values were considered to be within acceptable limits; however, the maximum values from all of the water plants were considered to be excessive. These maximum values ranged from 15 to 52 JTU.

Data available from the Group A water plants indicate that the turbidity levels increased slightly in the open water. While there has been considerable fluctuation in the maximum values during the 1968-1970 period, the annual average values have increased slightly from 1968 levels, with the highest values being recorded in 1969.

TABLE 4. TURBIDITY LEVELS IN LAKE MICHIGAN OPEN WATER, 1970

(Jackson Turbidity Units)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	3	38	11
North Chicago	3	25	8
Lake Forest	3	52	12
Highland Park	3	44	11
Glencoe	3	22	7
Winnetka	3	26	9
Kenilworth	3	52	12
Wilmette	3	50	10
Evanston	3	30	9
Chicago South	3	15	5

ODOR

Standard: No obnoxious odor of other than natural origin.

There were no significant odors in the raw water samples collected from the water filtration plants in 1970.

During 1968-1970, no significant odors were noted in samples collected from the Group A water plants.

OIL

Standard: Substantially free of visible floating oil.

Oil was not observed in any of the samples collected from the water filtration plants in 1970.

During 1968-1970, oil was not observed in any of the samples collected from the Group A water plants.

FLOATING SOLIDS AND DEBRIS

Standard: Substantially free of floating solids and debris from other than natural sources.

Floating solids and debris were not observed in raw water samples collected from the water filtration plants during 1968-1970.

TEMPERATURE
(Figure 4)

Standard: Not more than 85°F.

Temperature readings were within the standard in 1970.

Maximum temperature readings recorded in 1970 ranged from 68 to 76°F. The highest annual average temperature, 61°F., was recorded at the Chicago South plant.

It should be noted that the apparent temperature fluctuations shown in Figure 4 are the results of sampling schedules and frequencies rather than actual lake temperature changes of the magnitude suggested in the Figure.

TABLE 5. TEMPERATURE MEASUREMENTS FROM LAKE MICHIGAN OPEN WATER, 1970

(Degrees Fahrenheit)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	33	72	52
North Chicago	33	72	51
Lake Forest	44	76	55
Highland Park	37	73	57
Glencoe	38	69	54
Winnetka	38	73	54
Kenilworth	37	68	54
Wilmette	38	69	54
Evanston	35	72	54
Chicago South	41	73	61
SWB-7 Limit: Not more than		85	

pH - HYDROGEN ION CONCENTRATION
(Figure 5)

(Indicator as to whether water is acid, neutral or alkaline)

Standards: Annual Median - within range 8.1 - 8.4
Daily Median - within range 7.7 - 9.0

pH levels were within the standards in 1970.

Daily median values ranged from 7.9 to 8.7. Annual median values ranged from 8.2 to 8.3.

Data from the Group A plants indicate that pH values have remained generally stable with only fractional changes in the three-year period 1968-1970.

TABLE 6. pH LEVELS IN LAKE MICHIGAN OPEN WATER, 1970

(pH Units)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL MEDIAN
Waukegan	7.9	8.6	8.3
North Chicago	8.0	8.5	8.3
Lake Forest	8.0	8.4	8.2
Highland Park	8.0	8.5	8.3
Glencoe	8.2	8.6	8.3
Winnetka	8.1	8.7	8.3
Kenilworth	8.2	8.5	8.3
Wilmette	8.0	8.6	8.3
Evanston	8.0	8.5	8.3
Chicago South	8.0	8.6	8.3
SWB-7 Limits: Not more than	7.7	9.0	within range 8.1 - 8.4

AMMONIA NITROGEN (Figure 6) (A decomposition product of organic matter; an indicator of recent sewage contamination).

Standards:
Annual Average - 0.02 mg/l
Single Daily Value or Average - 0.05 mg/l

The concentrations of ammonia nitrogen were in general compliance with the standards in 1970.

While ammonia nitrogen concentrations were considered to be in general compliance, several high values were recorded. The highest single value exceeded the standard for single daily value at each plant except at the Evanston water plant, where measurable amounts of ammonia nitrogen were not recorded. These high values represent 12% of all the samples analyzed for ammonia nitrogen in 1970. The annual average standard was exceeded at the Glencoe, Kenilworth and the Chicago South water plants. In addition, the annual average values at five other water plants were at the maximum permissible level under this standard.

The data from the Group A water plants indicate that ammonia nitrogen concentrations have been decreasing in the open water. Maximum values decreased from a high of 0.80 mg/l in 1968 to 0.30 mg/l in 1970. Also, the annual average values in 1970 were lower than 1968 values at all plants except at the Chicago South water plant, where there has been a small annual increase each year since 1968.

TABLE 7. AMMONIA NITROGEN CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	0.00	0.10	0.02
North Chicago	0.00	0.10	0.01
Lake Forest	0.00	0.10	0.02
Highland Park	0.00	0.20	0.02
Glencoe	0.00	0.30	0.03
Winnetka	0.00	0.30	0.02
Kenilworth	0.00	0.20	0.03
Wilmette	0.00	0.30	0.02
Evanston	0.00	0.00	0.00
Chicago South	0.00	0.30	0.03
SWB-7 Limits: Not more than		0.05	0.02

METHYLENE BLUE ACTIVE SUBSTANCE (Figure 7) (An ingredient of detergents; toxic to fishes, causes undesirable tastes and produces unsightly, persistent foams)

Standards:
Annual Average - not more than 0.05 mg/l
Single Daily Value or Average - not more than 0.20 mg/l

MBAS concentrations exceeded the annual average standard in 1970.

The annual average values exceeded the maximum permissible limit at six of the water filtration plants. These values ranged from 0.06 mg/l at the Evanston and Chicago South water plants to 0.08 mg/l at the Glencoe and Waukegan water plants. Annual average values at three other plants were at the maximum permissible level. It is interesting to note that while the highest single values did not exceed the single daily value standard, Methylene Blue Active Substances were present in amounts sufficient to increase the annual average values to above permissible levels.

Data from the Group A water plants indicate that there has been a slight overall increase in the MBAS concentration from 1968 to 1970.

TABLE 8. MBAS CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	0.00	0.20	0.08
North Chicago	0.00	0.20	0.07
Lake Forest	0.00	0.10	0.04
Highland Park	0.00	0.20	0.07
Glencoe	0.00	0.20	0.08
Winnetka	0.00	0.10	0.05
Kenilworth	0.00	0.10	0.05
Wilmette	0.00	0.10	0.05
Evanston	0.00	0.10	0.06
Chicago South	0.00	0.10	0.06
SWB-7 Limits: Not more than		0.20	0.05

CHLORIDES
(Figure 8)

(A component of sewage, surface run-off, and industrial and agricultural wastes)

Standards:

Annual Average (Through 1970) - not more than 9 mg/l
Single Daily Value or Average - not more than 15 mg/l

The concentrations of chlorides exceeded the annual average standard in 1970.

The annual average standard was exceeded at five of the water filtration plants. The annual average value at these water plants was 10 mg/l. In addition, the annual average values at the other five plants were at the maximum permissible level. None of the single values exceeded the single daily value standard; the highest value recorded was 12 mg/l.

During the period 1968-1970, there has been a gradual increase in the chloride levels from all of the Group A water plants.

TABLE 9. CHLORIDE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	8	11	10
North Chicago	8	11	10
Lake Forest	8	11	9
Highland Park	8	11	10
Glencoe	8	10	9
Winnetka	8	12	10
Kenilworth	8	11	9
Wilmette	8	11	9
Evanston	8	11	9
Chicago South	8	11	10
SWB-7 Limits: Not more than		15	9

CYANIDES (A toxic industrial waste)

Standard: Single Value - not more than 0.025 mg/l

Measurable amounts of cyanides were not recorded in 1970.

During the 1968-1970 period, measurable amounts of cyanides were not recorded in the open water.

FLUORIDES (Normally present in water; abnormal fluctuation generally an indication of a waste discharge)

Standard: Annual Average - not more than 1.0 mg/l
Single Daily Value or Average - not more than 1.3 mg/l

The concentrations of fluorides were within the standards in 1970.

The annual average values at the ten water plants were uniformly low; the highest annual average value was 0.2 mg/l. The highest single values ranged from 0.2 to 0.8 mg/l.

There has been little significant change in the levels of fluorides from 1968 to 1970.

TABLE 10. FLUORIDE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	0.1	0.2	0.1
North Chicago	0.1	0.2	0.1
Lake Forest	0.1	0.5	0.2
Highland Park	0.1	0.2	0.1
Glencoe	0.1	0.2	0.2
Winnetka	0.1	0.2	0.2
Kenilworth	0.1	0.2	0.1
Wilmette	0.1	0.2	0.1
Evanston	0.1	0.2	0.1
Chicago South	0.1	0.8	0.2
SWB-7 Limits: Not more than		1.3	1.0

DISSOLVED IRON (Figure 9) (Usually an industrial waste product when present in significant amounts)

Standards: Annual Average - not more than 0.15 mg/l
Single Daily Value or Average - not more than 0.30 mg/l

The concentrations of dissolved iron were in general compliance with the standards in 1970.

The annual average standard was exceeded only at the Kenilworth water plant. Values at the other plants ranged from 0.05 to 0.13 mg/l. The single daily value standard was exceeded at seven plants; these values represent less than 6% of the total samples analyzed for dissolved iron in 1970.

During the 1968-1970 period, there has been an overall decrease in the concentration of dissolved iron in the open water. Maximum annual average values decreased from 0.41 to 0.13 mg/l during this period.

TABLE II. DISSOLVED IRON CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	0.05	0.70	0.12
North Chicago	0.05	0.20	0.07
Lake Forest	0.05	0.50	0.10
Highland Park	0.00	1.00	0.13
Glencoe	0.00	0.10	0.05
Winnetka	0.00	0.40	0.08
Kenilworth	0.05	1.30	0.19
Wilmette	0.00	1.10	0.13
Evanston	0.05	0.60	0.11
Chicago South	0.05	0.20	0.07
SWB-7 Limits: Not more than		0.30	0.15

PHENOL-LIKE SUBSTANCES (Usually indicative of industrial wastes; toxic to fishes, and causes taste and odor problems)

Standards: Annual Average - not more than 0.001 mg/l
Single Value - not more than 0.003 mg/l

The concentrations of phenols were in general compliance with the standards in 1970.

Single values exceeding the single daily value standard were recorded once each at the Waukegan, North Chicago, Highland Park, Evanston and the Chicago South plants. Values ranged from 0.017 to 0.020 mg/l. These values represent less than 3% of the total samples analyzed for phenols in 1970. These high values are reflected in the annual average values for these five plants, where the values are at the maximum permissible level.

Measurable amounts of phenols were not recorded at the water plants in 1969. Overall there has been little significant change in the levels of phenols in the open water in 1970 as compared to 1968.

SULFATES (Figure 10) (Commonly present in water; an indication of industrial wastes)

Standards: Annual Average (Through 1970) - not more than 24 mg/l
Single Daily Value or Average - not more than 50 mg/l

The concentrations of sulfates were within the standards in 1970.

The annual average values ranged from 20 to 21 mg/l; the maximum single value recorded in 1970 was 24 mg/l.

All of these values were within the applicable standard.

The data from the Group A water plants indicate that sulfate concentrations decreased in the open water. Maximum single values decreased from 60 to 24 mg/l from 1968 to 1970. The maximum annual average value decreased from 25 to 21 mg/l during this period.

TABLE 12. SULFATE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	18	24	21
North Chicago	18	22	20
Lake Forest	19	22	21
Highland Park	19	23	21
Glencoe	19	22	20
Winnetka	17	24	20
Kenilworth	19	24	21
Wilmette	19	23	20
Evanston	19	24	21
Chicago South	19	24	21
SWB-7 Limits: not more than		50	24

TOTAL PHOSPHATES (A component of treated sewage, industrial wastes,
(Figure 11) synthetic detergents and surface run-off)

Standards: Annual Average - not more than 0.03 mg/l
Single Daily Value or Average - not more than 0.04 mg/l

The concentrations of total phosphates exceeded the standards in 1970.

The annual average and single daily value standards were exceeded at all ten water plants by several orders of magnitude. Annual average values ranged from 0.08 mg/l at Evanston to 0.33 mg/l at Kenilworth. Sixty-nine percent of the samples analyzed for total phosphates exceeded the single daily value standard. The highest single value recorded in 1970 was 2.90 mg/l.

While the concentrations of total phosphates have been above acceptable levels in each of the three years from 1968 to 1970, there has been an overall decrease in the concentrations of total phosphates in the open water during this period. This is reflected in the data from the four North Shore Group A plants, where the annual average values and single values in 1970 were lower than the corresponding 1968 values.

The only exception was at the Chicago South water plant, where total phosphate values increased somewhat during this period. (Phosphate analyses in 1968 were conducted on unfiltered samples; samples tested in 1969-1970 were filtered prior to phosphate determination).

TABLE 13. TOTAL PHOSPHATE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	0.00	0.40	0.12
North Chicago	0.00	1.40	0.17
Lake Forest	0.00	0.40	0.12
Highland Park	0.00	0.60	0.16
Glencoe	0.00	0.80	0.17
Winnetka	0.00	0.40	0.15
Kenilworth	0.00	2.90	0.33
Wilmette	0.00	0.50	0.14
Evanston	0.00	0.20	0.08
Chicago South	0.00	0.40	0.12
SWB-7 Limits: Not more than		0.04	0.03

FILTRABLE RESIDUE (Total Dissolved Solids)
(Figure 12)

Standards: Annual Average (Through 1970) - not more than 165 mg/l
Single Daily Value or Average - not more than 200 mg/l

The concentrations of dissolved solids were within the standards in 1970.

The annual average and single daily value standards were exceeded only at the Waukegan water plant with values of 166 mg/l and 224 mg/l, respectively. Maximum single values at the other plants ranged from 166 mg/l at Glencoe to 182 mg/l at Highland Park.

Although the maximum values increased during the 1968-1970 period, the annual average values declined to within acceptable levels from the higher 1969 values.

TABLE 14. FILTRABLE RESIDUE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1970

(Milligrams per liter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	154	224	166
North Chicago	154	174	163
Lake Forest	158	178	163
Highland Park	156	182	163
Glencoe	158	166	161
Winnetka	158	175	162
Kenilworth	158	175	162
Wilmette	158	169	162
Evanston	158	169	162
Chicago South	158	171	163
SWB-7 Limits: Not more than		200	165

RADIONUCLIDES
(Figures 13 and 14)

(Alpha and beta emissions; any abnormal deviation from background levels may be indicative of pollution from industrial sources, such as nuclear power plants, or from fall-out).

Standard: Shall not be present in concentrations that will prevent meeting PHS 1962 Drinking Water Standards after conventional treatment.

The standard is not considered to be in violation as long as the concentrations of gross alpha and gross beta emitters do not exceed 3 picocuries per liter and 1,000 picocuries per liter, respectively.

The emission levels of radionuclides were within the standard in 1970.

Only one sample exceeded the gross alpha emission level in 1970. Measurable single values ranged from 1 to 5 pCi/l. The annual average gross alpha values were less than 1 pCi/l at all of the water plants.

Measurable gross beta radiation levels ranged from 2 to 24 pCi/l. Annual average values ranged from 4 to 5 pCi/l.

Little appreciable change has occurred in gross alpha and gross beta radiation levels during the 1968-1970 period.

TABLE 15. ALPHA AND BETA RADIOACTIVITY LEVELS IN LAKE MICHIGAN OPEN WATER, 1970

(Picocuries per liter)

WATER FILTRATION PLANT	MINIMUM		MAXIMUM		ANNUAL AVERAGE	
	Alpha	Beta	Alpha	Beta	Alpha	Beta
Waukegan	0	3	1	6	<1	4
North Chicago	0	0	1	7	<1	4
Lake Forest	0	2	5	24	<1	5
Highland Park	0	2	3	9	<1	5
Glencoe	0	3	0	6	0	4
Winnetka	0	3	1	5	<1	4
Kenilworth	0	3	3	8	<1	4
Wilmette	0	3	1	7	<1	5
Evanston	0	2	1	6	<1	4
Chicago South	0	3	0	6	0	4
SWB-7 Limits: Not more than			3	1,000		

FECAL COLIFORM (Indicators of recent contamination with feces of warm-blooded animals)

While standards have not been adopted for fecal coliform bacteria in Lake Michigan, there is increasing usage of this group of bacteria as an "indicator organism" in water pollution control activities. For this reason, fecal coliform data have been incorporated into this report. Fecal coliform standards established for primary contact recreation waters served as the basis for evaluation of Lake Michigan fecal coliform counts (Primary contact recreation is intended to include activities in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water).

Standards: Based on a minimum of not less than five samples taken over not more than a 30-day period, the fecal coliform content of primary contact recreation waters shall not exceed a geometric mean of 200/100 ml, nor shall more than 10% of total samples during any 30-day period exceed 400/100 ml.

Fecal coliform counts were within the standards in 1970.

The geometric mean values were uniformly low at all ten water plants. The highest geometric mean value was 2/100 ml. The highest recorded count in 1970 was 130/100 ml, which was recorded at the Lake Forest water plant. This was considered to be an unusually high count as the second highest value recorded for this plant in 1970 was 8/100 ml.

TABLE 16. FECAL COLIFORM COUNTS IN LAKE MICHIGAN OPEN WATER, 1970

(Expressed as numbers of bacteria per 100 milliters)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	GEOMETRIC MEAN
Waukegan	1	1	1
North Chicago	1	2	1
Lake Forest	1	130	2
Highland Park	1	20	2
Glencoe	1	14	1
Winnetka	1	28	2
Kenilworth	1	18	2
Wilmette	1	14	1
Evanston	1	10	1
Chicago South	1	6	1

Plankton (Minute, mostly microscopic plant and animal organisms which drift in the water subject to the action of waves and currents)

Although standards have not been adopted for planktonic organisms, data on their relative abundance are of value in determining eutrophication trends within the lake.

It should be noted that greater than 95% of the plankton counts were composed of phytoplankton organisms (algae). Maximum densities in 1970 ranged from 6,400 to 13,000/ml. Annual average densities ranged from 2,200 to 3,600/ml.

The maximum recorded counts increased slightly during the 1968-1970 period. However, the annual average counts decreased during this same period.

TABLE 17. PLANKTON DENSITIES IN LAKE MICHIGAN OPEN WATER, 1970

(Expressed as numbers of organisms per milliliter)

WATER FILTRATION PLANT	MINIMUM	MAXIMUM	ANNUAL AVERAGE
Waukegan	500	6,400	2,900
North Chicago	500	8,200	2,900
Lake Forest	500	7,300	3,100
Highland Park	500	8,200	3,600
Glencoe	500	9,100	2,700
Winnetka	500	13,000	3,200
Kenilworth	500	7,300	3,600
Wilmette	500	10,000	2,800
Evanston	500	8,200	2,900
Chicago South	500	6,400	2,200

OPEN WATER MONITORING BY SHIP

RESULTS AND EVALUATION

COLIFORM BACTERIA

Standard: Annual Average (Arithmetic) - not more than 200 per 100 ml
Single Daily Value or Average - not more than 2,500 per 100 ml

Coliform bacteria counts were within the standards in 1970.

The highest annual averages were recorded at the sampling stations offshore from the Wisconsin-Illinois State Line and Zion; respective counts were 68 and 51/100 ml. The highest single counts, which were well below the single daily value standard, were also recorded offshore from these two locations. The lowest surface counts were recorded offshore from Highland Park and the Chicago South water plant. The highest bottom count, 190/100 ml, was recorded offshore from the Chicago South water plant.

TABLE 18. COLIFORM BACTERIA COUNTS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Expressed as numbers of bacteria per 100 milliliters)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	SURFACE SAMPLES MAXIMUM	SURFACE SAMPLES ANNUAL AVERAGE	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	1	200	68	4
Zion	1	150	51	20
Waukegan	1	10	6	6
Highland Park	1	1	1	28
Winnetka	2	12	7	2
Evanston	1	20	11	60
Chicago Central Water Plant	1	4	3	4
Chicago South Water Plant	1	1	1	190
SWB-7 Limits: Not more than		2,500	200	2,500

* Only one sample collected at each station.

FECAL STREPTOCOCCI

Standard: Not more than 25 per 100 ml

Fecal streptococci counts were within the standard in 1970.

The fecal streptococci counts were uniformly low at all eight stations. The highest single count recorded in 1970 was 2/100 ml, which was recorded offshore from Highland Park. All other values were less than 2/100 ml.

TURBIDITY

Standard: No turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of the water.

Turbidity levels were considered to be within the standard in 1970.

The open water values were uniformly low at all sampling stations. The highest single value, 5 JTU, was recorded offshore from Evanston and the Chicago South water plant. Bottom turbidity values were also low; the maximum value recorded was 5 JTU.

TABLE 19. TURBIDITY LEVELS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Jackson Turbidity Units)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	SURFACE SAMPLES MAXIMUM	SURFACE SAMPLES ANNUAL AVERAGE	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	1	3	2	1
Zion	3	3	3	1
Waukegan	1	3	2	3
Highland Park	3	3	3	5
Winnetka	3	3	3	3
Evanston	3	5	4	3
Chicago Central Water Plant	3	3	3	3
Chicago South Water Plant	3	5	4	3

* Only one sample collected at each station.

ODOR

Standard: No obnoxious odor of other than natural origin.

Odors of other than natural origin were not noted in the open water in 1970.

OIL

Standard: Substantially free of visible floating oil.

Visible floating oil was not observed in the open water in 1970.

FLOATING SOLIDS AND DEBRIS

Standard: Substantially free of floating solids and debris from other than natural sources.

Floating solids and debris were not observed in the open water in 1970.

TEMPERATURE

Standard: Not more than 85°F.

Temperature readings were within the standard in 1970.

The highest temperature reading obtained in the open water, 74°F, was recorded offshore from Evanston and the Chicago Central water plant. Maximum surface temperatures ranged from 66 to 74°F. Bottom temperature readings ranged from 43 to 72°F.

TABLE 20. TEMPERATURE MEASUREMENTS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Degrees Fahrenheit)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES			BOTTOM SAMPLES
	MINIMUM	MAXIMUM	ANNUAL AVERAGE	*
Wisconsin-Illinois State Line	51	66	61	43
Zion	53	70	63	46
Waukegan	53	70	62	58
Highland Park	54	70	62	58
Winnetka	54	67	61	53
Evanston	74	74	74	65
Chicago Central Water Plant	55	74	65	72
Chicago South Water Plant	73	73	73	62
SWB-7 Limits: Not more than		85		85

* Only one sample collected at each station.

pH (Hydrogen Ion Concentration)

Standards: Annual Median - within range 8.1 - 8.4
Daily Median - within range 7.7 - 9.0

The pH range was within the standards in 1970.

The minimum and maximum values were all within the permissible daily median range. It should be noted that although none of the annual median values exceeded the annual median standard, the values at six of the eight stations were at the upper limit of the permissible range. Bottom pH values ranged from 8.1 to 8.5.

TABLE 21. pH LEVELS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(pH Units)

		SURFACE SAMPLES		BOTTOM SAMPLES
SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	MINIMUM	MAXIMUM	ANNUAL MEDIAN	*
Wisconsin-Illinois State Line	8.2	8.5	8.3	8.1
Zion	8.3	8.6	8.4	8.4
Waukegan	8.3	8.4	8.4	8.3
Highland Park	8.3	8.3	8.3	8.1
Winnetka	8.3	8.5	8.4	8.4
Evanston	8.2	8.6	8.4	8.4
Chicago Central Water Plant	8.3	8.5	8.4	8.5
Chicago South Water Plant	8.2	8.5	8.4	8.3
SWB-7 Limits: Not more than	7.7	9.0	8.1 - 8.4	

* Only one sample collected at each station.

DISSOLVED OXYGEN

Standards: Annual Average - not less than 90% saturation
Single Value - not less than 80% saturation

Dissolved oxygen levels were in compliance with the standards in 1970.

The minimum surface value in the open water, 85% saturation, was recorded offshore from the Wisconsin-Illinois State Line. All of the other minimum surface values were above 90% saturation. The annual average values were all above the minimum limit of 90% saturation. Bottom dissolved oxygen values ranged from 80 to 102% saturation. It should be noted that Lake Michigan is thermally stratified during part of the year, the apparent cause of lower dissolved oxygen levels near the lake bottom.

TABLE 22. DISSOLVED OXYGEN CONCENTRATIONS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Percent saturation)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES			BOTTOM SAMPLE
	MINIMUM	MAXIMUM	ANNUAL AVERAGE	*
Wisconsin-Illinois State Line	85	107	97	80
Zion	96	107	101	84
Waukegan	101	123	112	88
Highland Park	100	102	101	97
Winnetka	93	102	98	82
Evanston	110	110	110	100
Chicago Central Water Plant	94	110	102	102
Chicago South Water Plant	114	114	114	97
SWB-7 Limits: Not less than	80		90	80

* Only one sample collected at each station.

AMMONIA NITROGEN

Standards: Annual Average - 0.02 mg/l
Single Daily Value or Average - 0.05 mg/l

Ammonia nitrogen concentrations were within the standards in 1970.

Measurable amounts of ammonia nitrogen were recorded at only one station in the open water during 1970. On August 25, 1970, an ammonia nitrogen value of 0.10 mg/l was recorded offshore from Zion. This value exceeded the single daily value standard.

METHYLENE BLUE ACTIVE SUBSTANCE

Standards: Annual Average - not more than 0.05 mg/l
Single Daily Value or Average - not more than 0.20 mg/l

The concentrations of MBAS were in general compliance with the standards in 1970.

The annual average values obtained offshore from Zion and the Chicago South water plant exceeded the annual average standard. These values were 0.07 mg/l and 0.10 mg/l, respectively. The annual average values at three other stations were at the maximum permissible limit. The single daily value standard was not exceeded in 1970; however, the maximum permissible value was recorded once at four stations.

TABLE 23. MBAS CONCENTRATIONS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Milligrams per liter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES			BOTTOM SAMPLES
	MINIMUM	MAXIMUM	ANNUAL AVERAGE	*
Wisconsin-Illinois State Line	0.00	0.10	0.03	0.10
Zion	0.00	0.10	0.07	0.20
Waukegan	0.00	0.10	0.05	0.20
Highland Park	0.00	0.10	0.05	0.20
Winnetka	0.00	0.00	0.00	0.00
Evanston	0.00	0.10	0.05	0.00
Chicago Central Water Plant	0.00	0.00	0.00	0.00
Chicago South Water Plant	0.00	0.20	0.10	0.00
SWB-7 Limits: Not more than		0.20	0.05	0.20

* Only one sample collected at each station.

CHLORIDES

Standards: Annual Average (Through 1970) - not more than 9 mg/l
Single Daily Value or Average - not more than 15 mg/l

The concentrations of chlorides were in general compliance with the standards in 1970.

The annual average standard was exceeded at three stations. The values at the other five stations were at the maximum permissible limit. None of the single values exceeded the single daily value standard. The bottom value at all of the eight stations was 9 mg/l.

TABLE 24. CHLORIDE CONCENTRATIONS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Milligrams per liter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES			BOTTOM SAMPLE
	MINIMUM	MAXIMUM	ANNUAL AVERAGE	*
Wisconsin-Illinois State Line	9	10	9	9
Zion	9	10	9	9
Waukegan	10	10	10	9
Highland Park	9	10	10	9
Winnetka	9	10	10	9
Evanston	9	9	9	9
Chicago Central Water Plant	9	9	9	9
Chicago South Water Plant	9	9	9	9
SWB-7 Limits: Not more than		15	9	15

* Only one sample collected at each station.

CYANIDES

Standard: Single Value - not more than 0.025 mg/l

Measurable amounts of cyanides were not recorded in the open water in 1970.

FLUORIDES

Standards: Annual Average - not more than 1.0 mg/l
Single Daily Value or Average - not more than 1.3 mg/l

The concentrations of fluorides were within standards in 1970.

The highest single value recorded in 1970, 0.2 mg/l, was obtained from samples collected offshore from the Wisconsin-Illinois State Line and Zion. The annual average value was 0.1 mg/l at all of the eight sampling stations.

DISSOLVED IRON

Standards: Annual Average - not more than 0.15 mg/l
Single Daily Value or Average - not more than 0.30 mg/l

The maximum single values at all stations were in compliance in 1970; however, the annual average values at four stations exceeded the standard.

Values exceeding the annual average standard ranged from 0.20 to 0.30 mg/l. None of the single values exceeded the standard for single daily values. However, values obtained at three stations were at the maximum permissible limit. Bottom dissolved iron values ranged from 0.10 to 0.30 mg/l.

TABLE 25. DISSOLVED IRON CONCENTRATIONS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Milligrams per liter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	SURFACE SAMPLES MAXIMUM	SURFACE SAMPLES ANNUAL AVERAGE	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	0.20	0.30	0.25	0.30
Zion	0.20	0.20	0.20	0.10
Waukegan	0.10	0.20	0.15	0.20
Highland Park	0.10	0.10	0.10	0.20
Winnetka	0.00	0.00	0.00	0.10
Evanston	0.30	0.30	0.30	0.20
Chicago Central Water Plant	0.10	0.30	0.20	0.20
Chicago South Water Plant	0.00	0.00	0.00	0.10
SWB-7 Limits: Not more than		0.30	0.15	0.30

*Only one sample collected at each station.

PHENOL-LIKE SUBSTANCES

Standards: Annual Average - not more than 0.001 mg/l
Single Value - not more than 0.003 mg/l

Measurable amounts of phenols were not recorded in the open water in 1970.

SULFATES

Standards: Annual Average (Through 1970) - not more than 24 mg/l
Single Daily Value or Average - not more than 50 mg/l

The concentrations of sulfates were within the standards in 1970.

The standards for annual average and single daily values were not exceeded at any station. Annual average values ranged from 21 to 23 mg/l. The highest single value recorded in 1970 was 24 mg/l, which was well within the single daily value standard of 50 mg/l. Bottom values ranged from 19 to 22 mg/l.

TABLE 26. SULFATE CONCENTRATIONS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Milligrams per liter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	MAXIMUM	ANNUAL AVERAGE	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	20	24	22	22
Zion	20	23	22	22
Waukegan	23	23	23	22
Highland Park	22	24	23	22
Winnetka	20	24	22	19
Evanston	21	23	22	19
Chicago Central Water Plant	20	24	22	20
Chicago South Water Plant	20	22	21	20
SWB-7 Limits: Not more than		50	24	50

* Only one sample collected at each station.

TOTAL PHOSPHATES

Standards: Annual Average - not more than 0.03 mg/l
Single Daily Value or Average - not more than 0.04 mg/l

The concentrations of total phosphates exceeded the standards in 1970.

The values obtained at all of the sampling stations exceeded the applicable standards by several orders of magnitude. The maximum single values ranged from 0.10 to 0.50 mg/l. With the exception of the station offshore from Waukegan, even the minimum values exceeded the single daily value standard. Annual average values ranged from 0.10 to 0.30 mg/l.

TABLE 27. TOTAL PHOSPHATE CONCENTRATIONS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Milligrams per liter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	SURFACE SAMPLES MAXIMUM	SURFACE SAMPLES ANNUAL AVERAGE	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	0.10	0.40	0.20	0.10
Zion	0.10	0.30	0.17	0.10
Waukegan	0.00	0.10	0.05	0.40
Highland Park	0.10	0.50	0.30	0.10
Winnetka	0.10	0.10	0.10	0.00
Evanston	0.10	0.10	0.10	0.10
Chicago Central Water Plant	0.10	0.10	0.10	0.10
Chicago South Water Plant	0.10	0.10	0.10	0.10
SWB-7 Limits: Not more than		0.04	0.03	0.04

* Only one sample collected at each station.

FILTRABLE RESIDUE (Total Dissolved Solids)

Standards:
Annual Average (Through 1970) - not more than 165 mg/l
Single Daily Value or Average - not more than 200 mg/l

The concentrations of dissolved solids were in general compliance with the standards in 1970.

The annual average standard was exceeded offshore from the Chicago South water plant, and the value obtained offshore from Waukegan was the maximum permissible. Values from four other stations were just below the annual average limit. None of the single values exceeded the single daily value standard. Bottom values ranged from 164 to 174 mg/l.

TABLE 28. FILTRABLE RESIDUE CONCENTRATIONS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Milligrams per liter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	SURFACE SAMPLES MAXIMUM	SURFACE SAMPLES ANNUAL AVERAGE	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	145	163	156	164
Zion	145	164	157	164
Waukegan	163	167	165	167
Highland Park	160	167	164	167
Winnetka	158	168	163	168
Evanston	159	169	164	171
Chicago Central Water Plant	158	169	164	168
Chicago South Water Plant	167	169	168	169
SWB-7 Limits: Not more than		200	165	200

* Only one sample collected at each station.

RADIONUCLIDES

Standard: Shall not be present in concentrations that will prevent meeting PHS 1962 Drinking Water Standards after conventional treatment.

The standard is not considered to be in violation as long as the concentrations of gross alpha and gross beta emitters do not exceed 3 picocuries per liter and 1,000 picocuries per liter, respectively.

The gross alpha and gross beta emission levels were within the standard in 1970.

The highest gross alpha value, 1 pCi/l, was recorded offshore from Zion and Highland Park. The maximum gross beta value, 4 pCi/l, was obtained from water samples collected offshore from the six northernmost stations.

TABLE 29. ALPHA AND BETA RADIOACTIVITY LEVELS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Picocuries per liter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM		SURFACE SAMPLES MAXIMUM		SURFACE SAMPLES ANNUAL AVERAGE		BOTTOM SAMPLES *	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
Wisconsin-Illinois State Line	0	2	0	4	0	3	0	3
Zion	0	2	1	4	<1	3	0	4
Waukegan	0	3	0	4	0	4	1	5
Highland Park	0	4	1	4	<1	4	0	4
Winnetka	0	3	0	4	0	4	0	3
Evanston	0	4	0	4	0	4	0	3
Chicago Central Water Plant	0	3	0	3	0	3	2	3
Chicago South Water Plant	0	3	0	3	0	3	0	3
SWB-7 Limits: Not more than			3	1,000			3	1,000

* Only one sample collected at each station.

FECAL COLIFORM

Standard: None established. See page 18.

Fecal coliform counts were uniformly low at all of the sampling stations. The highest recorded count was 4/100 ml, which was recorded offshore from the Wisconsin-Illinois State Line.

TABLE 30. FECAL COLIFORM COUNTS AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Expressed as numbers of bacteria per 100 milliliters)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	MAXIMUM	GEOMETRIC MEAN	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	1	4	2	1
Zion	1	1	1	1
Waukegan	1	1	1	1
Highland Park	1	1	1	1
Winnetka	1	1	1	1
Evanston	1	1	1	1
Chicago Central Water Plant	1	1	1	1
Chicago South Water Plant	1	1	1	1

* Only one sample collected at each station.

PLANKTON

Standard: None established. See page 19.

Surface plankton densities ranged from 200 to 2,300/ml four miles from shore. The highest surface densities ranged from 900/ml offshore from Highland Park and the Chicago South water plant to 2,300/ml offshore from Winnetka and the Wisconsin-Illinois State Line. Bottom densities ranged from 200 to 2,700/ml.

TABLE 31. PLANKTON DENSITIES AT OFFSHORE SHIP SAMPLING STATIONS, 1970

(Expressed as numbers of organisms per milliliter)

SHIP STATIONS LOCATED 4 MILES OFFSHORE FROM:	SURFACE SAMPLES MINIMUM	MAXIMUM	ANNUAL AVERAGE	BOTTOM SAMPLES *
Wisconsin-Illinois State Line	900	2,300	1,400	200
Zion	200	1,400	800	200
Waukegan	200	1,800	1,000	900
Highland Park	500	900	700	2,700
Winnetka	1,800	2,300	2,000	1,800
Evanston	500	1,800	1,200	2,300
Chicago Central Water Plant	1,400	1,800	1,600	1,400
Chicago South Water Plant	900	900	900	500

* Only one sample collected at each station.

SECCHI DISC MEASUREMENTS (A measure of light penetration in water).

Although standards have not been adopted for this parameter, Secchi disc measurements are a useful index for determining the clarity or transparency of a body of water. Light penetration in water is affected by the presence or absence of suspended and colloidal matter.

In 1970 the areas of greatest light penetration were recorded offshore from Zion and Waukegan, where the Secchi disc readings were 19 feet. The areas of least light penetration were found at the State Line and Calumet River stations within Calumet Harbor, where the Secchi disc readings were 4 and 9 feet, respectively.

TABLE 32. SECCHI DISC MEASUREMENTS

(Values expressed in feet)

LOCATION	MINIMUM	MAXIMUM	AVERAGE
Wisconsin-Illinois State Line	13	13	13 *
Zion	11	19	15
Waukegan	19	19	19 *
Highland Park	15	15	15 *
Winnetka	15	15	15 *
Chicago Central Water Plant	15	15	15 *
U.S. Established Dump Zone	11	21	18
Calumet Harbor at State Line	4	4	4
Calumet Harbor at Calumet River Mouth	6	9	7½

* Based on one reading.

U.S. ESTABLISHED DUMPING AREA WATER MONITORING, 1970

RESULTS AND EVALUATION

The data presented in this section have been evaluated on the basis of the standards previously included in this report in the Open Water Monitoring section.

COLIFORM BACTERIA

Coliform bacteria counts were well within the standards for annual average and single daily values. The maximum value was 28/100 ml.

FECAL STREPTOCOCCI

Fecal streptococci counts were in compliance with the standard. In the open waters, fecal streptococci counts may not exceed 25/100 ml; the maximum recorded count was 1/100 ml.

TURBIDITY

Turbidity levels were in compliance with the standard. A maximum value of 5 JTU was recorded.

ODOR

Odors were not detected.

OIL

Visible floating oil was not observed.

FLOATING SOLIDS AND DEBRIS

Floating solids and debris were not observed.

TEMPERATURE

Temperatures were well within the standard. The highest temperature recorded at the Dumping Area was 57°F. All temperatures were taken in the fall of the year.

pH (HYDROGEN ION CONCENTRATION)

pH values complied with the standards. Single values ranged from 8.3 to 8.5, well within the limits of the daily median standard. The annual median of 8.4 was at the maximum permissible value.

DISSOLVED OXYGEN

The annual average and minimum single values were well above the minimum limit of the open water standard. Values ranged between 91 and 100% saturation.

AMMONIA NITROGEN

Measurable amounts of ammonia nitrogen were not recorded at the Dumping Area.

METHYLENE BLUE ACTIVE SUBSTANCE

The MBAS annual average was 0.10 mg/l, which exceeded the established standard of 0.05 mg/l. The single daily average did not exceed the 0.20 mg/l standard.

CHLORIDES

The annual average value of 10 mg/l for chlorides exceeded the 9 mg/l standard. The single daily value or average did not exceed the 15 mg/l standard.

CYANIDES

Measurable amounts of cyanides were not recorded.

FLUORIDES

The levels of fluorides were well within the established standards. All samples collected had values of 0.1 mg/l.

DISSOLVED IRON

The annual average of 0.08 mg/l of dissolved iron did not exceed the 0.15 mg/l standard. One sample containing 0.60 mg/l of dissolved iron exceeded the single value standard.

PHENOL-LIKE SUBSTANCES

Measurable amounts of phenols were not recorded.

SULFATES

Sulfate concentrations met the standards. The annual average value of 19 mg/l did not exceed the annual average standard. Also, the maximum recorded value, 21 mg/l, was well within the single value standard of 50 mg/l.

TOTAL PHOSPHATES

Phosphate concentrations exceeded the standards. The annual average of 0.46 mg/l exceeded the annual average standard while eight of nine of the samples exceeded the single value standard.

FILTRABLE RESIDUE (Total Dissolved solids)

The levels of dissolved solids met the standards. No values exceeded either the annual average or the single daily value standards. The highest value, 161 mg/l, was within the single value standard of 200 mg/l.

RADIONUCLIDES

Nine samples were analyzed for radioactivity levels. The levels of gross alpha and gross beta emitters in all of the samples were well within the standards.

PLANKTON

Surface and mid depth plankton samples were collected. Plankton densities ranged between 900 and 2700 per milliliter at both locations.

SECCHI DISC MEASUREMENTS (See Table 32)

Secchi disc readings averaged 18 feet and ranged between 11 and 21 feet. No standards have been established for the degree of light penetration.

TABLE 33. WATER QUALITY AT THE U.S. ESTABLISHED DUMPING AREA

PARAMETER	MINIMUM	MAXIMUM	ANNUAL AVERAGE	SWB-7 ANNUAL AVERAGE STANDARD
Coliform Bacteria	1	28	7	Not more than 200/100 ml
Fecal Streptococci	1	1	1	Not more than 25/100 ml
Turbidity	1	5	4	--------------------JTU
Temperature	54	57	56	Not more than 85°F
pH	8.3	8.5	8.4	Within range 8.1-8.4
Dissolved Oxygen	91	100	97	Not less than 90% Saturation
MBAS	0.00	0.20	0.10	Not more than 0.05 mg/l
Chlorides	9	11	10	Not more than 9 mg/l
Fluorides	0.1	0.1	0.1	Not more than 1.0 mg/l
Dissolved Iron	0.00	0.60	0.08	Not more than 0.15 mg/l
Sulfates	18	21	19	Not more than 24 mg/l
Total Phosphates	0.00	2.30	0.46	Not more than 0.03 mg/l
Filtrable Residue	152	161	158	Not more than 165 mg/l
Radionuclides				
Alpha	0	0	0	Not more than 3 pCi/l
Beta	2	4	3	Not more than 1,000 pCi/l
Fecal Coliform	1	4	2*	------------Number/100 ml
Phytoplankton	900	2700	1900	------------Number/ml

* Geometric Mean

CALUMET HARBOR WATER QUALITY MONITORING - 1970

RESULTS AND EVALUATION

COLIFORM BACTERIA

Standards: Annual Average (Arithmetic) - Not more than 2,000 per 100 ml
Single Daily Value or Average - Not more than 5,000 per 100 ml

Coliform bacteria counts were within the standards.

The highest single count recorded in 1970 was 800/100 ml, which was recorded at the Calumet River station. Annual average counts were 487 and 513/100 ml at the State Line station and the Calumet River station, respectively.

FECAL STREPTOCOCCI

Standard: Not more than 100 per 100 ml

Fecal streptococci counts were within the standard.

The maximum recorded count was 20/100 ml, which was obtained from a sample collected at the State Line station. The maximum count recorded at the Calumet River station was 5/100 ml.

TURBIDITY

Standard: No turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of the water.

Turbidity levels were low at both sampling stations. Maximum values recorded at the State Line and Calumet River stations were 6 and 7 JTU, respectively.

ODOR

Standard: No obnoxious odor of other than natural origin.

No unusual or obnoxious odors were noted in water samples collected within the Calumet Harbor Basin.

TEMPERATURE

Standard: Not more than 85°F

Temperature readings were within the standard.

Temperature readings ranged from 53 to 66°F at the State Line station. At the Calumet River station, temperatures ranged from 54 to 63°F.

OIL

Standard: Substantially free of visible floating oil.

Substantial amounts of oil were observed at the State Line station on two occasions; visible floating oil was not observed at the Calumet River station.

FLOATING SOLIDS AND DEBRIS

Standard: Substantially free of floating solids and debris from other than natural sources.

Significant amounts of floating solids and debris were not observed within the Calumet Harbor Basin.

pH (HYDROGEN ION CONCENTRATION)

Standard: Annual Median - within range 8.0 - 8.5
Daily Median - within range 7.5 - 9.0

The pH levels were within the standards.

Single values ranged from 8.2 to 8.5 at both stations. The annual median value at each station was 8.3.

DISSOLVED OXYGEN

Standards: Annual Average - not less than 80% saturation
Single Daily Value or Average - not less than 65% saturation

Dissolved oxygen levels were within the standards.

Minimum dissolved oxygen values at the State Line and Calumet River stations were 82 and 81% saturation, respectively. The lowest annual average value, 88% saturation, was recorded at the Calumet River station.

AMMONIA NITROGEN

Standard: Annual Average - 0.05 mg/l
Single Daily Value or Average - 0.12 mg/l

Measurable amounts of ammonia nitrogen were not recorded in the Calumet Harbor Basin.

METHYLENE BLUE ACTIVE SUBSTANCE

Standard: Annual Average - not more than 0.10 mg/l
Single Daily Value or Average - not more than 0.30 mg/l

The MBAS values were within the standards.

The highest single value recorded at both stations was 0.10 mg/l. Annual average values ranged from 0.03 mg/l at the Calumet River station to 0.07 mg/l at the State Line station.

CHLORIDES

Standards: Annual Average (Through 1970) - not more than 18 mg/l
Single Daily Value or Average - not more than 30 mg/l

The concentrations of chlorides were within the standards.

The highest single value recorded at both stations was 10 mg/l. At both stations, the annual average value was also 10 mg/l.

CYANIDES

Standard: Single Value - less than 0.1 mg/l

There were no measurable amounts of cyanides recorded in the Calumet Harbor Basin.

FLUORIDES

Standards: Annual Average - not more than 1.0 mg/l
Single Daily Value or Average - not more than 1.3 mg/l

Fluoride levels were within the standards.

The highest single value, 0.3 mg/l, was recorded at the State Line station. Annual average values at the State Line and Calumet River stations were 0.3 and 0.2 mg/l, respectively.

DISSOLVED IRON

Standards: Annual Average - not more than 0.15 mg/l
Single Daily Value or Average - not more than 0.30 mg/l

Water samples were analyzed for dissolved iron once each at the two sampling stations. Dissolved iron values of 0.10 and 0.20 mg/l were recorded at the State Line and Calumet River stations, respectively. These values were within the single daily value standard; considered on an annual basis, the 0.20 mg/l value exceeded the annual average standard.

PHENOL-LIKE SUBSTANCES

Standards: Annual Average - not more than 0.002 mg/l
Single Daily Value or Average - not more than 0.005 mg/l

Measurable amounts of phenols were not recorded in the Calumet Harbor Basin.

SULFATES

Standards: Annual Average (Through 1970) - not more than 36 mg/l
Single Daily Value or Average - not more than 75 mg/l

The concentrations of sulfates were within the standards.

The annual average value at both sampling stations was 26 mg/l. The highest single values were 36 mg/l at the State Line station and 39 mg/l at the Calumet River station.

TOTAL PHOSPHATES

Standards: Annual Average - not more than 0.05 mg/l
Single Daily Value or Average - not more than 0.10 mg/l

The concentrations of total phosphates exceeded the standards in 1970.

The annual average value at both stations, 0.15 mg/l, exceeded the standard. In addition, the highest single value recorded at both stations, 0.30 mg/l, exceeded the single daily value standard.

FILTRABLE RESIDUE (Total Dissolved Solids)

Standards: Annual Average (Through 1970) - not more than 190 mg/l
Single Daily Value or Average not more than 230 mg/l

The concentrations of dissolved solids were within the standards.

At both stations, the single daily values ranged from 167 to 178 mg/l. The annual average at both stations was 171 mg/l.

RADIONUCLIDES

Standard: Shall not be present in concentrations that will prevent meeting PHS 1962 Drinking Water Standards after conventional treatment.

Measurable amounts of gross alpha emmissions were not recorded in the Calumet Harbor Basin.

Gross beta values ranged from 2 to 13 pCi/l. The maximum recorded values were 4 pCi/l at the Calumet River station and 13 pCi/l at the State Line station. All of these values were well within acceptable limits.

FECAL COLIFORM

Maximum fecal coliform counts ranged from 50/100 ml at the State Line station to 130/100 ml at the Calumet River station. These values were considered to be within acceptable limits.

SECCHI DISC MEASUREMENTS (See Table 32)

Secchi disc readings averaged 5.8 feet and ranged between 4 and 9 feet. No standards have been established for the degree of light penetration.

TABLE 34. WATER QUALITY AT THE STATE LINE STATION, CALUMET HARBOR BASIN

PARAMETER	MINIMUM	MAXIMUM	ANNUAL AVERAGE	SWB-15 ANNUAL AVERAGE STANDARD
Coliform Bacteria	160	700	487	Not more than 2,000/100 ml
Fecal Streptococci	10	20	17	Not more than 100/100 ml
Turbidity	3	6	5	----- JTU
Temperature	53	66	61	Not more than 85°F
pH	8.2	8.5	8.3	Within range 8.0 - 8.5
Dissolved Oxygen	82	106	95	Not less than 80% saturation
MBAS	0.00	0.10	0.07	Not more than 0.10 mg/l
Chlorides	10	10	10	Not more than 18 mg/l
Fluorides	0.2	0.3	0.3	Not more than 1.0 mg/l
Dissolved Iron	0.10	0.10	0.10	Not more than 0.15 mg/l
Sulfates	20	36	26	Not more than 36 mg/l
Total Phosphates	0.00	0.30	0.15	Not more than 0.05 mg/l
Filtrable Residue	167	178	171	Not more than 190 mg/l
Radionuclides				
Alpha	0	0	0	Not more than 3 pCi/l
Beta	3	13	6	Not more than 1,000 pCi/l
Fecal Coliform	1	50	17*	----Number/100 ml

* Geometric Mean

TABLE 35. WATER QUALITY AT THE CALUMET RIVER STATION, CALUMET HARBOR BASIN

PARAMETER	MINIMUM	MAXIMUM	ANNUAL AVERAGE	SWB-15 ANNUAL AVERAGE STANDARD
Coliform Bacteria	40	800	513	Not more than 2,000/100 ml
Fecal Streptococci	2	5	4	Not more than 100/100 ml
Turbidity	5	7	6	- - - - JTU
Temperature	54	62	59	Not more than 85°F
pH	8.2	8.5	8.3	Within range 8.0 - 8.5
Dissolved Oxygen	81	92	88	Not less than 80% saturation
MBAS	0.00	0.10	0.03	Not more than 0.10 mg/l
Chlorides	9	10	10	Not more than 18 mg/l
Fluorides	0.2	0.2	0.2	Not more than 1.0 mg/l
Dissolved Iron	0.20	0.20	0.20	Not more than 0.15 mg/l
Sulfates	20	39	26	Not more than 36 mg/l
Total Phosphates	0.00	0.30	0.15	Not more than 0.05 mg/l
Filtrable Residue	167	178	171	Not more than 190 mg/l
Radionuclides				
Alpha	0	0	0	Not more than 3 pCi/l
Beta	2	4	3	Not more than 1,000 pCi/l
Fecal Coliform	14	130	41*	____ Number/100 ml

* Geometric Mean

LAKE BED SURVEY

GENERAL INFORMATION

Senate Bill 1794 establishes the authority for the State to conduct lake bed surveys in order to evaluate the ecology of aquatic organisms in Lake Michigan. Regulation SWB-7 requires that bottom deposits in Lake Michigan be "Substantially free of contaminants that will: (1) adversely alter the composition of the bottom fauna; (2) interfere with the spawning of fish or their eggs; (3) adversely alter the physical or chemical nature of the bottom."

To evaluate any change in the bottom life of Lake Michigan one hundred and seven bottom samples were collected in 1970 using the Peterson and Ponar dredges. Each sample was washed through a 30 mesh screen and the remaining portion was preserved for later identification of the collected organisms. Each sample was classified as containing a natural population of aquatic organisms or a degraded population. The system of classification was based partially on that used by the Illinois Department of Public Health and the criteria used by the former Federal Water Quality Administration.

Generally a polluted condition is indicated by a population of 100 or more aquatic worms per square foot of bottom and a clean water situation is indicated by 150 scuds per square foot of bottom. These criteria are considered together with the numbers and species of all organisms found in a sample to give the final classification. A well-balanced population will include a variety of species. A degraded environment usually reduces the total number of species while it increases the number of individuals of the few remaining species which are more tolerant of polluted conditions.

RESULTS AND EVALUATION OF MONITORING

Dredge samples were collected at fifty-seven established stations from Zion to Calumet Harbor in 1970 (Figure 17 and 18). The stations ranged from less than a mile to five miles offshore. Depths at which samples were taken ranged from eleven to one hundred feet.

Fifty samples were collected from seven additional areas. These stations were located within one mile from shore. Samples were collected in depths ranging from 6 to 36 feet offshore from the Commonwealth Edison plant in Zion, the Commonwealth Edison plant in Waukegan, the U.S. Steel plant in Waukegan, the North Chicago sewage treatment plant outfall, the outfall utilized by Abbott Laboratories in North Chicago, the Lincoln Park Gun Club in Chicago, and Calumet Harbor in Chicago.

Three samples were collected at the U.S. Authorized Dumping Zone at depths between 50 and 80 feet and between 9½ to 13½ miles offshore from Chicago.

Fifty-three percent of the stations from Zion to Calumet Harbor were indicative of a biologically altered condition (Tables 36, 37 and 38). In 1969 a dredge survey of these same stations found 57.9% were degraded.

The fact that a lower percentage of polluted stations were found in 1970 does not mean that the lake is in a better condition than the year before. This difference can be attributed to sampling variability alone. The number of degraded stations remains near 50%; this is approximately what was found in 1969. Scattered locations along the Illinois portion of Lake Michigan had population and bottom organisms that indicated a polluted environment. The most severely polluted conditions were indicated at twelve stations that had aquatic worm populations in excess of 200 per square foot of bottom. These were stations 1,3,8,11,12,18,20,30,33,43,50 and 54. Station 3 located off Zion and station 8 located in the harbor of the Great Lakes Naval Training Center had aquatic worm populations in excess of 10,000 per square foot. The majority of these stations had the characteristic organically enriched muck bottom which supports great numbers of aquatic worms. This type of bottom is not typical of the natural state of the lake bottom which normally consists of sand, pebbles, clay, mud, and rocks.

Eleven stations had scud populations in excess of 150 per square foot of bottom. Ten of these were located along Lake County from Zion to Highwood. Generally populations of this size indicate a clean water condition. Considering other factors, two of these stations were classified as biologically degraded. Stations with a balanced population and scud populations in excess of 150 per square foot were found at station numbers 2, 4,5,7,9,10,11,15 and 53. The bottom type at the majority of these stations was in a natural state and was usually a fine sand.

TABLE 36. Organisms collected during dredging surveys from Zion to Highwood. Numbers expressed on a per square foot basis.

STATION	Scuds (Amphipoda)	Aquatic Sow Bugs (Isopoda)	Bryozoans (Bryozoa)	Hydra (Hydrozoa)	Water Mites (Hydracarina)	Fingernail Clams (Sphaeriidae)	Gill Snails (Prosobranchia)	Midges (Tendipedidae)	Pulmonate Snails (Pulmonata)	Leeches (Hirudinea)	Aquatic Worms (Oligochaeta)	*Opossum Shrimp (Mysidacea)	*Seed Shrimp (Ostracoda)
1	388	<1	—	—	—	241	4	33	1	—	439	—	—
2	847	—	—	—	—	161	6	1	5	1	37	—	—
3	229	—	—	—	—	1080	19	28	12	—	22,500	—	—
4	703	—	—	—	—	416	2	2	—	—	2	—	—
5	1262	—	—	—	—	187	28	13	4	7	187	—	—
6	85	—	—	—	—	133	2	4	—	1	146	—	—
7	667	1	—	—	—	9	1	1	2	—	—	—	—
8	—	—	—	—	—	34	—	4	—	—	10,000	—	—
9	543	—	—	—	—	28	79	5	—	1	8	—	—
10	260	—	—	—	—	164	4	8	62	1	—	—	—
11	625	—	—	—	—	12	7	48	—	—	306	—	—
12	20	—	—	—	—	7	2	288	4	20	2200	—	—
13	73	—	—	—	1	—	2	13	1	3	47	—	—
14	4	—	—	—	—	2	—	6	—	—	6	—	—
15	468	—	—	—	1	130	23	20	4	—	99	1	—
16	32	23	—	12	2	—	—	—	11	4	9	—	2
17	38	20	—	—	—	5	—	56	—	—	79	—	—
18	36	—	X	—	—	85	—	876	—	36	2800	—	—
19	21	1	—	—	3	—	1	18	3	3	29	—	—
20	18	—	—	—	—	—	—	27	—	—	404	—	—

* Collected incidentally during bottom sampling.

X Present in sample; number of colonies not differentiated.

TABLE 37. Organisms collected during dredging surveys from Highland Park to Evanston. Numbers expressed on a per square foot basis.

STATION	Caddis Fly (Trichoptera)	Scuds (Amphipoda)	Aquatic Sow Bugs (Isopoda)	Bryozoans (Bryozoa)	Hydra (Hydrozoa)	Water Mites (Hydracarina)	Fingernail Clams (Sphaeriidae)	Snails-Gill (Prosobranchia)	Flatworm (Turbellaria)	Midges (Tendipedidae)	Snails-Pulmonate (Pulmonata)	Leeches (Hirudinea)	Roundworms (Nematoda)	Aquatic Worms (Oligochaeta)	* Copepods (Copepoda)	* Water Fleas (Cladocera)
21	—	9	—	—	—	—	4	—	—	3	—	—	—	27	—	—
22	—	5	1	—	4	5	3	2	—	5	5	5	1	19	1	1
23	—	14	—	—	4	4	4	—	—	16	5	2	—	135	—	—
24	—	5	—	—	—	2	5	18	—	5	7	—	—	16	—	11
25	—	16	—	—	—	4	4	—	—	5	2	2	—	9	—	2
26	—	14	—	—	—	—	30	—	—	2	2	—	—	82	—	—
27	—	94	—	—	—	—	5	—	—	—	5	—	—	32	—	—
28	—	2	—	X	—	13	—	—	—	—	—	1	—	29	4	2
29	—	—	—	X	—	7	4	—	—	—	4	—	—	4	—	—
30	—	107	—	—	—	—	125	2	—	295	2	18	—	1450	—	—
31	—	1	—	—	—	—		—	—	3	—	2	—	3	—	—
32	5	22	—	—	—	2	—	1	4	1	4	—	—	4	—	—
33	—	2	—	—	—	4	—	—	—	25	—	4	—	317	—	—
34	—	—	—	—	—	—	—	Rock - No Sample			—	—	—	—	—	—
35	—	15	—	X	—	—	3	—	—	1	1	28	—	120	1	—
36	—	—	—	—	—	—	—	Rock - No Sample			—	—	—	—	—	—

* Collected incidentally during bottom sampling.

X Present in sample; number of colonies not differentiated.

TABLE 38. Organisms collected during dredging surveys off Chicago. Numbers expressed on a per square foot basis.

STATION	Caddis Fly (Trichoptera)	Scuds (Amphipoda)	Aquatic Sow Bugs (Isopoda)	Bryozoans (Bryozoa)	Hydra (Hydrozoa)	Water Mites (Hydracarina)	Fingernail Clams (Sphaeriidae)	Snails-Gill (Prosobranchia)	Flatworm (Turbellaria)	Midges (Tendipedidae)	Snails-Pulmonate (Pulmonata)	Leeches (Hirudinea)	Roundworms (Nematoda)	Aquatic Worms (Oligochaeta)	* Copepods (Copepoda)	* Water Fleas (Cladocera)
37	—	—	—	—	—	—	ROCK-NO SAMPLE			—	—	—	—	—	—	—
38	1	7	—	X	—	—	—	1	5	—	1	—	—	1	—	—
39	5	—	—	—	—	—	—	—	—	2	—	—	—	27	—	—
40	—	12	—	—	—	5	3	—	—	15	—	1	—	93	3	—
41	1	19	—	—	—		8	1	1	—	1	1	1	32	—	—
42	—	7	—	—	—	2	4	—	—	7	—	4	—	123	—	—
43	—	14	—	—	—	—	237	9	—	2	—	24	—	1100	—	—
44	—	6	—	—	—	1	2	—	—	4	—	1	—	1	—	—
45	—	37	—	X	—	3	1	1	—	—	—	1	—	43	—	—
46	—	1	—	X	—	—	—	—	—	—	—	—	—	2	—	—
47	—	8	—	—	—	—	1	—	—	—	—	< 1	—	5	—	—
48	1	20	—	X	—	1	8	—	—	—	2	1	—	23	—	—
49	—	89	1	X	—	1	280	21	—	7	3	8	2	162	2	1
50	—	25	1	—	—	1	392	7	—	36	3	33	—	1300	—	—
51	—	20	—	X	—	1	26	1	—	—	1	10	—	20	—	—
52	—	40	—	—	—	2	37	11	—	2	—	2	2	49	—	—
53	—	177	—	—	—	—	6	7	—	1	2	2	—	7	—	1
54	—	12	1	—	—	1	154	1	—	28	—	25	—	650	—	—
55	—	—	—	—	—	—	6	—	—	—	—	1	—	1	—	—
56	—	2	—	—	5	—	—	—	—	—	—	—	—	12	4	—
57	—	1	—	X	—	3	—	—	—	16	—	—	1	12	6	—
58	—	41	—	—	—	1	36	1	—	3	3	1	—	3	—	—
59	—	17	—	—	—	1	1	1	—	1	1	—	—	7	—	—
60	—	15	—	—	—	1	2	1	—	2	—	—	—	7	4	—

* Collected incidentally during bottom sampling.

X Present in sample; number of colonies not differentiated.

Ten samples were collected off the Commonwealth Edison Nuclear Plant at Zion (Figure 19). Only two stations were indicative of a biologically degraded environment (Table 39). Both of these stations were in water less than fifteen feet in depth. The lake bottom at most stations was fine sand.

TABLE 39. Organisms collected during dredging surveys near the Commonwealth Edison plant at Zion. Numbers expressed on a per square foot basis.

ORGANISMS	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
Scuds (Amphipoda)	221	581	282	170	20	31	309	584	524	511
Hydra (Hydrozoa)	—	1	—	—	—	—	—	—	—	1
Water Mites (Hydracarina)	—	1	—	—	—	—	—	—	—	1
Fingernail Clams (Sphaeriidae)	2	59	53	4	1	—	76	103	53	20
Snails-Gill (Prosobranchia)	—	2	1	—	—	—	1	1	1	1
Midges (Tendipedidae)	11	15	7	11	11	18	4	8	9	11
Snails-Pulmonate (Pulmonata)	1	1	2	1	—	1	—	2	2	2
Leeches (Hirudinea)	—	—	2	—	—	—	—	—	—	1
Aquatic Worms (Oligochaeta)	88	53	65	57	109	119	69	38	28	97
Totals	323	713	412	243	141	169	459	736	617	645

COMMONWEALTH EDISON PLANT AT WAUKEGAN

Five samples were collected off the Commonwealth Edison Plant at Waukegan (Figure 20). Two of the five samples were indicative of a polluted condition (Table 40). The lake bottom consisted of fine sand and occasional fine gravel and black fines.

TABLE 40. Bottom organisms collected during dredging surveys off the Commonwealth Edison power generating station in Waukegan. Numbers expressed on a per square foot basis.

ORGANISMS	STATION NUMBER				
	1	2	3	4	5
Scuds (Amphipoda)	85	458	493	423	352
Fingernail Clams (Sphaeriidae)	—	25	18	387	44
Gill Snails (Prosobranchia)	—	9	12	—	—
Midge Fly Larvae (Tendipedidae)	1	13	6	122	10
Pulmonate Snails (Pulmonata)	—	15	12	2	5
Leeches (Hirudinea)	—	—	1	1	—
Aquatic Worms (Oligochaeta)	9	41	94	346	235
Totals	95	561	636	1281	646

UNITED STATES STEEL PLANT, WAUKEGAN

Six samples were collected off the United States Steel plant in Waukegan (Figure 21). Five of the six samples were indicative of a polluted environment (Table 41). The lake bottom consisted mainly of fine sand with occasional small gravel.

TABLE 41. Organisms collected during dredging surveys off the United States Steel plant in Waukegan. Numbers expressed on a per square foot basis.

ORGANISMS	STATION NUMBER					
	1	2	3	4	5	6
Scuds (Amphipoda)	—	2	—	10	4	7
Water Mites (Hydracarina)	—	1	—	4	—	—
Midge Fly Larvae (Tendipedidae)	—	—	—	2	1	7
Aquatic Worms (Oligochaeta)	—	3	2	8	6	14
Water Fleas* (Cladocera)	—	—	—	—	1	—
Totals	0	6	2	24	12	28

* Collected incidentally during bottom sampling.

Eight stations were sampled off outfalls that serve the North Chicago N.S.S.D. sewage treatment plant and Abbott Laboratories (Figure 21). Six of the eight stations sampled were classified as biologically altered (Table 42). Stations seven and eight showed an increased number of scuds and more species indicating a clean water situation. The relatively high numbers of aquatic worms at these stations indicate some organic enrichment. The lake bottom consisted of fine sand at all stations.

TABLE 42. Bottom organisms found during dredging surveys off the N.S.S.D. sewage treatment plant and Abbott Laboratories outfalls at North Chicago. Numbers expressed on a per square foot basis.

ORGANISMS	STATION NUMBER							
	1	2	3	4	5	6	7	8
Scuds (Amphipoda)	7	9	2	—	53	19	122	273
Aquatic Sow Bugs (Isopoda)	—	2	—	—	—	—	1	1
Water Mites (Hydracarina)	—	—	—	—	—	—	1	1
Fingernail Clams (Sphaeriidae)	—	—	—	1	3	13	43	45
Gill Snails (Prosobranchia)	—	—	—	—	—	—	5	15
Midges (Tendipedidae)	1	—	1	2	31	12	4	9
Pulmonate Snails (Pulmonata)	—	1	—	—	—	—	2	6
Leeches (Hirudinea)	—	1	—	—	—	—	6	3
Aquatic Worms (Oligochaeta)	13	32	2	75	561	62	95	136
Totals	21	45	5	78	648	106	279	489

Thirteen samples were collected off the Lincoln Park Gun Club and all but one (92.3%) reflected a biologically degraded environment (Figure 22). Lead pellets were found at all but three of the stations and ranged as high as 148 pellets per square foot of lake bottom at station 8 (Table 43). It has been estimated that 50,000 pounds of lead shot are expended in a year's time at the gun club. In addition plastic shot cups and an estimated 250,000 pounds of clay targets fall into the lake each year causing a further accumulation of debris. The lake bottom consisted of sand at all stations. Some clay was found at Station 8.

TABLE 43. Bottom organisms and lead shotgun pellets collected during dredging surveys off the Lincoln Park Gun Club. Numbers expressed on a per square foot basis.

STATION	1	2	3	4	5	6	7	8	9	10[1]	11	12	13
Scuds (Amphipoda)	—	—	—	2	9	5	11	—	—	—	21	5	45
Fingernail Clams (Sphaeriidae)	2	4	—	—	125	57	210	27	2	11	59	69	68
Gill Snail (Prosobranchia)	—	—	—	—	4	—	—	—	—	—	—	2	—
Midge Fly Larvae (Tendipedidae)	2	5	—	—	21	7	—	14	—	—	7	—	4
Pulmonate Snails (Pulmonata)	—	—	—	—	—	—	—	—	—	—	—	4	7
Leeches (Hirudinea)	—	—	—	—	—	4	9	2	—	—	5	—	—
Roundworms (Nematoda)	—	9	—	—	61	—	—	—	—	—	—	—	—
Aquatic Worms (Oligochaeta)	52	23	—	—	48	299	376	66	—	2	352	16	48
Total Organisms	56	41	0	2	268	372	606	109	2	13	444	96	181
Lead Pellets	5	39	94	0	64	9	105	148	39	0	12	16	11

(1) Bryozoans present in sample; number of colonies not differentiated.
(2) Nine unidentified diptera larvae found at this station.

CALUMET HARBOR AREA

Five samples were collected in the Calumet Harbor area (Figure 23). All the samples collected indicated a polluted environment (Table 44). No life of any kind was found at three of the five stations. The survey showed the lake bottom to consist of oily muck and metal fines. This type of polluted environment is not suitable for a normal bottom population.

TABLE 44. Bottom organisms found during dredging survey in the Calumet Harbor area. Numbers expressed on a per square foot basis.

ORGANISMS	STATION NUMBER 1	2	3	4	5
Fingernail Clams (Sphaeriidae)	—	—	—	—	9
Gill Snails (Prosobranchia)	—	—	—	—	1
Pulmonate Snails (Pulmonata)	—	—	—	—	—
Midge Fly Larvae (Tendipedidae)	—	—	—	—	2
Leeches (Hirudinea)	—	—	—	—	1
Aquatic Worms (Oligochaeta)	—	—	—	4	6
Totals	0	0	0	4	19

Three stations were sampled at the U.S. Established Dumping Area (Figure 18). Two of the three stations sampled indicated a polluted environment (Table 45). Adverse weather and a short sampling season limited further sampling in this area.

TABLE 45. Bottom organisms collected during bottom surveys in the U.S. Established Dumping Area.

ORGANISMS	STATION LOCATION		
	1	2[a]	3
Scuds (Amphipoda)	11	107	4
Aquatic Sow Bugs (Isopoda)	—	—	4
Fingernail Clams (Sphaeriidae)	7	14	—
Midges (Tendipedidae)	14	1	3
Snails - Pulmonate (Pulmonata)	—	1	1
Leeches (Hirudinea)	2	2	—
Aquatic Worms (Oligochaeta)	2300	96	62
Totals	2334	221	74

[a] A small sculpin (25 mm. total length) was collected incidentally during dredging surveys at this station.

SPECIAL SAMPLING

GENERAL INFORMATION

Sampling was conducted to gather background data on several substances for which there has been much concern on their effect to the environment and to man himself. Information obtained from this sampling would be used to identify sources which cause pollution or degradation of the lake environment. With this information action could then be taken to stop sources of pollution. Both mercury and pesticides were monitored as part of this program. More detailed analyses of fish samples were made to include pesticides, mercury, lead, and selenium (Tables 47 and 49). Fish samples were obtained from the Illinois Conservation Department and commercial fishermen. Water and sediment samples were analyzed for pesticides. Additional water samples were also analyzed for mercury. Results of pesticide analyses (Tables 46, 47 and 48) have been made available to the Technical Committee on Pesticides established under the Lake Michigan - Four State Federal Enforcement Conference, to be used in making committee recommendations to the conference conferees.

PESTICIDE MONITORING

On June 25, 1969 the Pesticide Control Law was passed in Illinois. The act provided for labeling of pesticides to prevent contamination of water and environment by regulating, restricting or prohibiting the sale, use or application of pesticides. The sale, use or application of DDT was prohibited in Illinois without a permit from the Director of the Department of Public Health, effective January 1, 1970. With these regulations it is hoped that there will be a reduction in the amount of all pesticides released into the environment.

A monitoring program was initiated in the fall of 1970 to determine the present levels of several pesticides in Lake Michigan sediments, water, and fish. Water and sediment samples were collected in Lake Michigan and several ravines and tributaries to the lake (Figure 24). In addition fish samples were obtained from the Waukegan and Chicago areas. Laboratory tests were run to determine concentrations of dieldrin, heptachlor epoxide, and DDT on all samples.

Water samples were collected at two tributary streams, seven sewage treatment plants, six water treatment plants and three open lake locations. All water samples ranged below 15.1 parts per trillion total DDT, 1.1 parts per trillion heptachlor epoxide and 2.6 parts per trillion dieldrin (Table 46).

Water samples collected from water treatment plants and four miles offshore had concentrations below one part per trillion for all pesticides for which tests were made.

Highest values for all three pesticides in water samples were found in the tributary streams and sewage treatment plant effluents. Values for total DDT ranged from 2.5 to 15.0 parts per trillion, heptachlor epoxide from<0.1 to 1.0 parts per trillion, and dieldrin from 0.6 to 2.5 parts per trillion.

Pesticide tolerance limits were not set when the drinking water standards were established by the United States Public Health Service in 1962. No tolerance levels have been established in fish, but the United States Food and Drug Administration has confiscated lots of fish when tests show a concentration of greater than 5.0 parts per million DDT.

The Technical Committee on Pesticides established under the Lake Michigan Enforcement Conference recommended that the concentration of DDT in fish should not exceed 1.0 parts per million DDT, 0.5 parts per million DDD, 0.1 parts per million dieldrin, and that all other chlorinated hydrocarbon insecticides, singly or combined, should not exceed 0.1 parts per million based on the wet weight of the tissue sampled.

Four species of fish from Lake Michigan were analyzed for pesticides (Table 47). These were yellow perch, coho salmon, chubs and brown trout. Heptachlor epoxide and dieldrin concentrations for all species did not exceed 0.1 parts per million. DDT values ranged from 1.0 in yellow perch females to 3.2 parts per million in a composite sample of chubs of both sexes.

All fish were below the 5.0 parts per million action level for DDT utilized by the U.S. Food and Drug Administration. Dieldrin levels were below the limit recommended by the Lake Michigan Technical Committee on Pesticides. It is doubtful that if more parameters were tested that the 0.1 parts per million total concentration limit for all pesticides would be met.

Sediment samples were collected at thirteen locations (Table 48). Concentrations of DDT were found to range between<0.1 and 0.9 parts per million. All samples had concentrations of heptachlor epoxide and dieldrin of 0.1 parts per million or less.

The levels of pesticides found in Lake Michigan water and fish were found to be within presently accepted guidelines. There is good reason to believe that the levels of pesticides presently found in the environment can be reduced through proper regulation and use. While research is being accomplished to obtain a better picture of the complete biological implications of pesticides, the Illinois Environmental Protection Agency will continue a monitoring program.

TABLE 46. Concentrations of three pesticides found in water samples from Lake Michigan and tributary sources in Illinois in 1970. Values expressed as parts per trillion.

SAMPLE LOCATION	TOTAL DDT	HEPTACHLOR EPOXIDE	DIELDRIN
Tributary Streams[1]			
Waukegan River	6.3	1.0	1.4
Pettibone Creek	15.0	0.1	0.9
Sewage Treatment Plants[2]			
NSSD Waukegan	11.2	0.7	2.4
NSSD North Chicago	7.6	0.6	2.5
NSSD Lake Bluff	2.5	<0.1	1.5
NSSD Lake Forest	3.5	0.1	2.2
NSSD Highland Park - Park Avenue	3.2	0.1	1.6
NSSD Highland Park - Ravine Drive	9.1	0.1	2.3
NSSD Highland Park - Cary Avenue	2.6	0.1	0.6
Open Water Samples[3]			
Winthrop Harbor	0.4	<0.1	0.1
Evanston	0.2	<0.1	0.1
Chicago[4]	0.3	<0.1	0.1
Water Plant Samples[5]			
Waukegan	0.9	<0.1	0.1
North Chicago	0.5	<0.1	0.1
Highland Park	0.4	<0.1	0.1
Evanston	0.6	<0.1	0.1
Chicago Central	0.3	<0.1	0.1
Chicago South	0.3	<0.1	0.1

[1] 50 yards upstream from Lake Michigan.
[2] Final effluent to Lake Michigan
[3] 4 miles offshore.
[4] 4 miles offshore from Chicago central water plant.
[5] Crib water samples ranging from 1/3 to 2 1/4 miles offshore.

TABLE 47. Concentrations of three pesticides found in fish samples collected in Lake Michigan in 1970. Concentrations expressed in parts per million.

SPECIES	NUMBER ANALYZED	SAMPLE LOCATION	TOTAL DDT	HEPTACHLOR EPOXIDE	DIELDRIN
Yellow Perch					
Male	10	Chicago	1.6	0.1	0.1
Female	10	Chicago	1.0	0.1	0.1
Coho Salmon					
Male	8	Waukegan	1.9	<0.1	<0.1
Female	5	Waukegan, Chicago	1.7	<0.1	<0.1
Chubs[1]					
Both sexes	10	Waukegan	3.2	0.1	0.1
Brown Trout					
Female	3	Chicago	3.0	<0.1	<0.1

[1] Collected December 1970; all other samples were collected in November 1970.

TABLE 48. Concentrations of three pesticides found in sediments from Lake Michigan and tributary streams and ravines. Concentrations expressed in parts per million. All samples were collected October 15, 1970.

SAMPLE LOCATION	TOTAL DDT	HEPTACHLOR EPOXIDE	DIELDRIN
Tributary Streams[1]			
Waukegan River	0.1	<0.1	<0.1
Pettibone Creek	0.7	<0.1	<0.1
Ravines and Intermittent Streams			
Lake Bluff-Ravine	0.1	<0.1	<0.1
Lake Forest-Woodland Drive Ravine	0.9	0.1	<0.1
Lake Forest - Barat Creek	0.1	<0.1	<0.1
Highland Park - Ravine Drive Ravine	0.3	<0.1	<0.1
Lake Sediments[2]			
Waukegan	<0.1	<0.1	<0.1
North Chicago	<0.1	<0.1	<0.1
Lake Bluff	<0.1	<0.1	<0.1
Lake Forest	<0.1	<0.1	<0.1
Highland Park (Park Avenue)	<0.1	<0.1	<0.1
Highland Park (Ravine Drive)	<0.1	<0.1	<0.1
Highland Park (Cary Avenue)	<0.1	<0.1	<0.1

[1] 50 yards upstream from Lake Michigan.

[2] 40-80 yards offshore of the indicated sewage treatment plant.

MERCURY AND OTHER HEAVY METAL MONITORING

In the open waters of Lake Michigan concentrations of trace contaminants must meet the PHS 1962 Drinking Water Standards after conventional treatment. Iron standards adopted in SWB-7 further limit concentrations of dissolved iron (see page 13).

On March 31, 1971 the Illinois Pollution Control Board adopted "#R70-5: Mercury Regulations." These regulations amended Water Quality Standards SWB-7 through SWB-15 to provide that concentrations of mercury shall not exceed 0.0005 mg/l in any stream, lake or groundwater. With few exceptions the same was also established as an effluent regulation.

WATER SAMPLES

Fifty-one water samples collected from water plants and from open water during ship sampling were analyzed for copper, cadmium, lead, zinc, hexavalent chromium, trivalent chromium, arsenic, barium, and manganese. One hundred and eighty samples were analyzed for iron and forty-three samples were analyzed for mercury.

Twelve mercury samples were collected at water treatment plants in June and thirty-one samples were collected at open water locations 4 to 13½ miles offshore in August and October. No mercury was detected in any of the forty-three samples at the lowest level of detectability which was 0.001 mg/l. Present laboratory capabilities now allow the detection of mercury in water down to 0.0005 mg/l.

Analyses for heavy metals showed measurable readings only for zinc and iron. The maximum value recorded for iron was 1.30 mg/l recorded at the Kenilworth water plant. The maximum value recorded for zinc was 0.25 mg/l recorded at the Highland Park water plant.

FISH SAMPLES

Edible portions of nine species of fish were analyzed for mercury, lead, and selenium content (Table 49). Mercury levels averaged 0.303 ppm in 50 fish, lead averaged 0.165 ppm in 46 fish, and selenium averaged 0.311 ppm in 49 fish. All values are expressed on a wet weight basis.

Most species tested for mercury showed values near the average of 0.303 ppm. A composite sample of two carp from the Chicago area showed the lowest concentration of mercury found, 0.076 ppm. The highest concentration of mercury, 0.654 ppm, was found in a composite of four goldfish from the North Chicago area. From this limited sampling no trend was evident in either the predators or the bottom feeding fish. It is felt that while these data reflect the influence of their environment, fish movement has prevented any detailed interpretation.

TABLE 49. Concentrations of lead, mercury and selenium found in flesh of nine species of Lake Michigan fish. Values expressed as parts per million on a wet weight basis.

LOCATION	SPECIES	NUMBER OF FISH IN SAMPLE	PARTS PER MILLION		
			LEAD	MERCURY	SELENIUM*
WAUKEGAN					
	Smelt	3	0.347	0.227	0.652
	Alewife	4	0.135	0.271	0.095
	Chub	15	0.077	0.212	0.325
NORTH CHICAGO					
	Coho Salmon	11	0.063	0.329	0.317**
	Brown Trout	3	0.292***	0.302	0.236
	Carp	1	-----	0.294	0.148
	Goldfish	4	0.410	0.654	0.220
	Carp X Goldfish	1	<0.005	0.266	0.476
	White Sucker	1	-----	0.290	0.550
CHICAGO					
	Yellow Perch	2	0.207	0.273	0.480
	Coho Salmon	3	0.560	0.498	0.183
	Carp	2	0.075	0.076	0.294
	Average for all fish		0.165	0.303	0.311

* Values reported on samples that were somewhat dehydrated from storage.

** Value based on ten fish.

*** Value based on one fish.

Although mercury values exceeded the interim Food and Drug Administration standard of 0.5 ppm only once, it should be noted that a sample of three coho salmon from the Chicago area had a value close to this standard. It is evident from these data that further sampling is needed to obtain a clearer picture of the concentrations of heavy metals in fish. Sampling in 1971 will be directed toward larger samples of carp, yellow perch, chubs, alewife and coho salmon to be analyzed for lead, mercury, and selenium.

In fish samples analyzed for lead the coho salmon showed both the highest and the second lowest values. More variation was indicated by a relatively high value found in a sample of four goldfish while samples of two carp and one carp X goldfish hybrid had low values.

Selenium concentrations in fish flesh showed a similar variation and average when compared to mercury. Values reported for selenium are considered somewhat higher than true values because it was not possible to obtain a true wet weight on samples that had been stored for a long period of time. The significance of heavy metals in the Lake Michigan environment is presently being investigated by a technical committee established under the Lake Michigan - Four State Federal Enforcement Conference.

LAKE MICHIGAN

ENFORCEMENT CONFERENCES

In March, 1965, the Lake Michigan - Calumet Area Enforcement Conference established a deadline of December 31, 1968 for construction of necessary pollution control facilities for municipalities and industries in the Calumet area. Subsequent sessions of this conference extended the deadlines for some of the Indiana industries to 1972.

In January, 1968, the Secretary of the Interior, at the request of the governor of Illinois, called the Lake Michigan - Four State Federal Enforcement Conference. Representatives from Illinois, Indiana, Michigan and Wisconsin established, at that time, a schedule for the construction of municipal and industrial pollution control facilities in the entire Lake Michigan basin. This conference instituted programs for:

a) Control of watercraft toilet wastes.

b) Phosphate reduction in sewage plant effluents.

c) Control of combined sewer overflows.

d) Prohibiting dumping of pollutional material in the lake.

e) Disinfection of sewage plant effluents.

f) Monitoring of Lake Michigan water quality.

Subsequent sessions in March, May and September of 1970 received progress reports on the original recommendations. Special consideration was given to the problems of thermal pollution, phosphate and, most recently, the total dissolved solids introduction to Lake Michigan.

LEGISLATIVE AND

REGULATORY ACTION

The following material provides a brief, chronological history of the activities of Illinois which have some bearing on the quality of Lake Michigan water.

STANDARDS

In September, 1966, the Illinois Sanitary Water Board adopted water quality standards (SWB-7) which include standards for Lake Michigan open water. These standards, along with implementation plans and compliance schedules, were approved by the U.S. Department of the Interior in January, 1968. The Illinois Pollution Control Board amended the standards in May, 1971.

DUMPING

In October, 1967, Senate Bill 1794, approved unanimously, prohibited further deposition of any material in Lake Michigan except with the joint permission of the state pollution control agency (EPA) and the Illinois Department of Public Works and Buildings. To date, the only permits issued involve non-pollutional material, such as steel pilings, concrete structures or clean sand.

WATERCRAFT

In July, 1968, Illinois adopted regulations (SWB-19) prohibiting the discharge of sewage and wastes from watercraft to state waters. These regulations became effective January, 1970 (See page 69).

DDT

In June, 1969, the 76th General Assembly approved an act prohibiting the sale and use of DDT in Illinois, except when the Illinois Department of Public Health allows its use in quelling an immediate threat to public health. The law became effective in January, 1970, and the Department of Agriculture is the regulatory agency.

FILTER BACKWASH

In October, 1969, the Illinois Sanitary Water Board officially recognized as a pollutant the filter backwash from water filtration plants. Illinois municipalities and the federal military installations operating water filtration plants on Lake Michigan are expected to provide adequate treatment of backwash water by July, 1972.

ENFORCEMENT

In July, 1970, the governor's Environmental Protection Act came into effect. A Pollution Control Board of five members was appointed as a judicial body in pollution control activities. To regulate and enforce the act, an Environmental Protection Agency was formed. This agency assumed all of the pollution control responsibilities formerly delegated to the Illinois Department of Public Health. The governor's program included an Institute for Environmental Quality, which promotes research activities.

FINANCING

In November, 1970, Illinois voters approved the issuance of $750,000,000 in bonds to assist municipalities and sanitary districts in financing construction, expansion and improvement of sewage treatment facilities. The combination of state and federal grant programs makes it possible for a municipality to receive assistance amounting to 80% of the project cost.

SEWAGE TREATMENT PLANTS

DISCHARGING TO LAKE MICHIGAN

NORTH SHORE SANITARY DISTRICT

There are only seven Illinois municipal sewage treatment plants tributary to Lake Michigan. They are all operated by the North Shore Sanitary District and are located in Waukegan, North Chicago, Lake Bluff, Lake Forest and Highland Park (3 plants). The Waukegan and North Chicago plants provide secondary (biological) treatment. The others are primary (sedimentation) sewage treatment plants. All provide disinfection (chlorination) of their effluent. Except for the one at Lake Forest, all the plants are operating at or in excess of their design capacities. Therefore, particularly during periods of rain or thaw, inadequately treated waste is discharged to Lake Michigan. During the summer months, the excess flows are chlorinated, since all of these plants are in close proximity to public bathing areas.

The North Shore Sanitary District is now engaged in an extensive construction program, which, when completed, will divert all sewage effluent from the Lake Michigan watershed. The program provides for the diversion of the effluents from the Lake Bluff, Lake Forest and Highland Park plants to the District's Clavey Road sewage treatment plant (DesPlaines River watershed), which will be expanded. The North Chicago sewage treatment plant effluent will be diverted to a proposed new facility to be located in Gurnee (DesPlaines River watershed). Supplementary treatment and phosphate reduction facilities will be provided at the Waukegan sewage treatment plant. The effluent from the Waukegan plant will then be pumped for discharge to the DesPlaines River.

In 1968, the District's voters passed a referendum providing $35 million for the initial phase of the expansion projects. The last of these bonds was reportedly issued in May, 1971 Construction at the Clavey Road sewage treatment plant was begun during 1969, but litigation instituted by a group of Highland Park residents has resulted in delays of the project schedule. After six days of public hearings, the Illinois Pollution Control Board ordered the District, on March 31, 1971, to complete immediately and expeditiously its proposed expansion facilities. This order authorizes the District to issue any additional bonds required to complete the program without the passage of a public referendum. If no other legal opposition occurs, the project schedule shows completion dates, for the advanced waste water treatment facilities at Gurnee and Waukegan, of February and November, 1974, respectively. The most recent total project costs are presently estimated to be $95.27 million.

MILITARY INSTALLATIONS

Three military installations have sewage treatment facilities tributary to Lake Michigan. All three provide secondary treatment and disinfection of the effluent. Camp Logan, a state facility, has made arrangements to connect to the North Shore Sanitary District. The Great Lakes Naval Training Center and Fort Sheridan are federal installations and are under orders from the President to provide adequate treatment by 1972. Currently, these two installations are negotiating for connection to the North Shore Sanitary District.

ILLINOIS INDUSTRIES

DISCHARGING TO LAKE MICHIGAN

ABBOTT LABORATORIES (Manufacturers of drugs, antibiotics and pharmaceuticals). Abbott operates a waste treatment plant which provides secondary (biological) treatment of their extremely strong industrial waste. The effluent from this plant is mixed with other spent process, cooling and storm water before discharge to the lake. They are currently engaged in a $2.5 million pollution control program. The flow equalization tanks have been expanded, additional aeration equipment has been provided, a new clarifier has been completed, all waste carrying sewers have been renovated, the spent fermentation beer is now being processed for poultry feed supplements and the construction of dikes for collection of accidentally spilled materials is progressing according to schedule. They describe the current pollution control program as "substantially completed."

Presently, the company is evaluating two choices for further treatment of their wastes. The effluent from the present secondary treatment plant will either be diverted to the proposed North Shore Sanitary District treatment plant at Gurnee, or else, Abbott will construct and operate its own advanced treatment plant. A 600 gallon per day pilot plant is now operational and a six month study is being conducted. Therefore even if the North Shore Sanitary District experiences scheduling set-backs, or is for any reason unable to accept the additional waste load, Abbott's waste will receive advanced treatment in the near future.

COMMONWEALTH EDISON COMPANY, WAUKEGAN STATION (Fossil fuel electric generating station). This plant has been operating since 1927. At full capacity, the maximum temperature rise through the condensers is 12°F. Extensive studies of the thermal plume effect on the localized portion of the lake have identified no adverse effect.

COMMONWEALTH EDISON COMPANY, ZION STATION (Nuclear fuel electric generating station). This controversial facility is currently under construction. Units 1 and 2 are to be completed in 1972 and 1973 respectively. At full capacity, the maximum temperature rise through the condensers is not expected to exceed 20°F. The Illinois Pollution Control Board has ruled that technical testimony does not substantiate the claim of possible thermal pollution. They have authorized the facility to utilize Lake Michigan for cooling providing the lake ambient temperature is not increased 3°F, 1000 ft. from the point of discharge.

FANSTEEL METALURGICAL CORPORATION (producers of corrosion-resistant metals used in electrical contacts, rectifiers, capacitors and chemical plants). Fansteel discharges wastes to Pettibone Creek roughly one mile upstream of its confluence with Lake Michigan in concentrations frequently in excess of Environmental Protection Agency limits. Fansteel submitted a program for waste treatment in March, 1971, which is currently being evaluated.

OUTBOARD MARINE CORPORATION (Manufacturers of marine engines). The effluent from oil separating equipment is discharged to Waukegan Harbor and through a ditch to Lake Michigan several hundred yards north of Waukegan's North Beach. Metal concentrations in the discharge are all within the Environmental Protection Agency limits. Occasional oil discharges seldom pass the barriers and baffles which cross the effluent ditch.

UNITED STATES STEEL CORPORATION, WAUKEGAN WORKS (Producers of stainless and carbon steel wire and springs). In-plant improvements and acid waste hauling for deep well disposal in Gary, Indiana, have resulted in major reduction of wastes discharged to the lake. The current discharge, via six outfalls, occasionally exceeds the effluent quality requirements of the Environmental Protection Agency.

UNITED STATES STEEL CORPORATION, SOUTH WORKS To protect the interests of all concerned in the current litigation, no summary of progress will be included in this report. However, recent action by the Illinois Attorney General's Office has resulted in an agreement with U.S. Steel to provide a closed cycle system by 1975.

WATERCRAFT WASTES

On January 1, 1970, the State of Illinois Sanitary Water Board Rules and Regulations, SWB-19, prohibiting discharge of marine toilet wastes, became effective. Although the rule allows for the use of treatment systems, none of the present systems for treating watercraft wastes have demonstrated the required degree of treatment. Therefore, retaining-type or incinerating toilets are the only approved systems.

The City of Chicago has a local ordinance which makes unlawful the discharge of marine toilet wastes in Chicago Harbors and inshore waters. This ordinance is effectively enforced by the Chicago Park District, which denies mooring permits to vessels that are not in compliance. Non-retaining type toilet systems must be officially sealed to make them inoperative while in Chicago Harbors. The Chicago Park District provides free pump-out stations for servicing the retaining-type toilet systems. The stations are located at Montrose, Belmont, Diversey, Burham, 59th Street and Jackson Park Harbors. Since most of the boats that use the Illinois portion of Lake Michigan are moored in Chicago Harbors, the ordinance is effective in abating pollution by watercraft wastes.

METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

All of the lake shore municipalities in Cook County (Glencoe through Chicago) are served by the Metropolitan Sanitary District of Greater Chicago. Except for several surface drains, no sewers within the jurisdiction of the District discharge directly to Lake Michigan. The District's three major sewage treatment plants and combined sewers (sewage and storm water) discharge to a system of waterways which are tributary to the DesPlaines River. Lock and dam facilities prevent back-flow of contaminated river water into Lake Michigan. Heavy rains may cause such heavy discharge to these waterways that the water level rises above the level of the lake resulting in back-flow through the locks and overflow of the dams. Therefore, the District maintains an alert system with the Lockport control facilities. Whenever heavy rain is predicted, the Lockport Dam lowers the water level in the rivers and thereby prevents or minimizes the discharge from the MSDGC waterways to Lake Michigan. The last such discharge occurred on August 16, 1968.

LEGEND FOR FIGURES 1 THROUGH 16

Water quality data obtained from five Lake Michigan water filtration plants (designated as Group A plants in this report) during the period 1968-1970 are summarized in Figures 1 through 16.

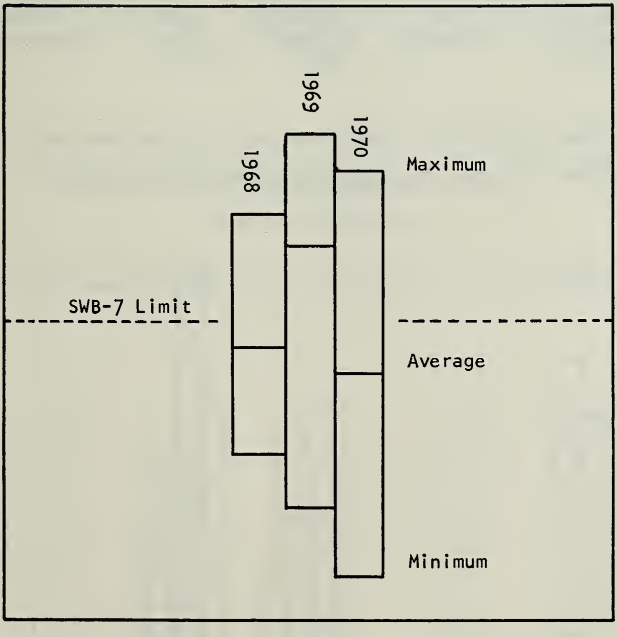


FIGURE 1. COLIFORM BACTERIA COUNTS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Numbers of bacteria per 100 milliliters)

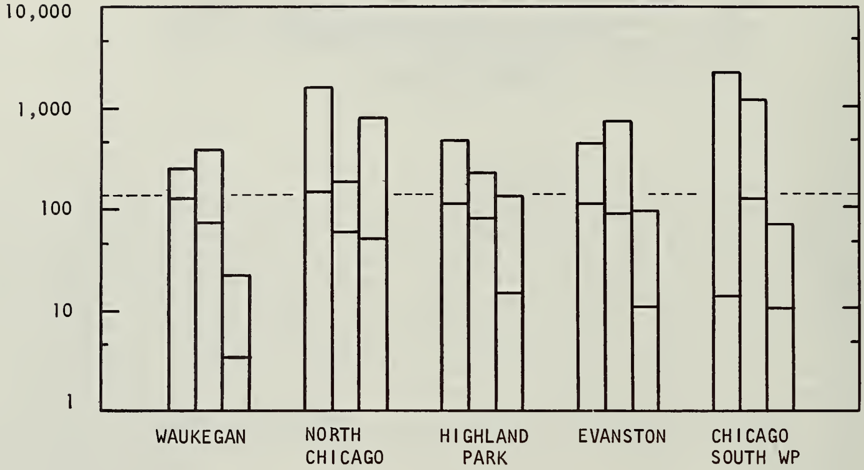
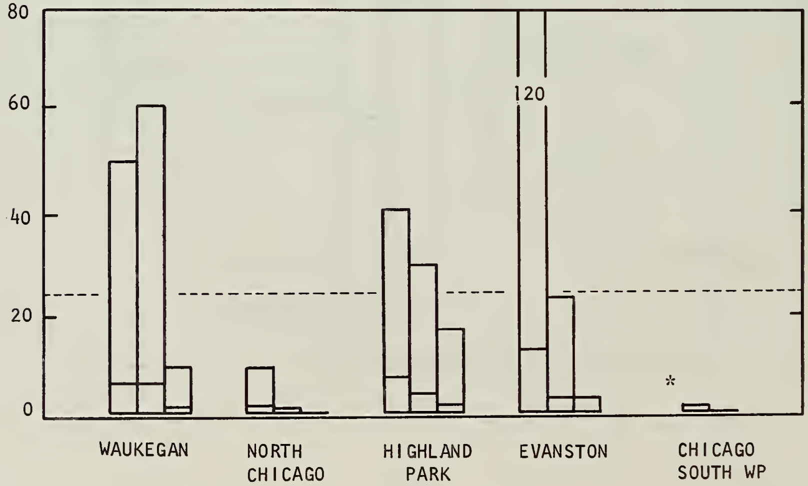


FIGURE 2. FECAL STREPTOCOCCI COUNTS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Numbers of bacteria per 100 milliliters)



* 1968 Data not available

(See page 71 for legend)

FIGURE 3. TURBIDITY LEVELS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Jackson Turbidity Units)

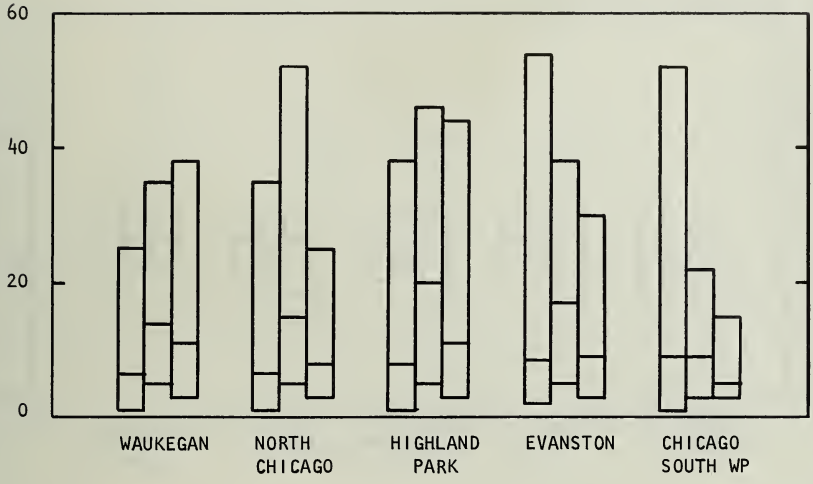
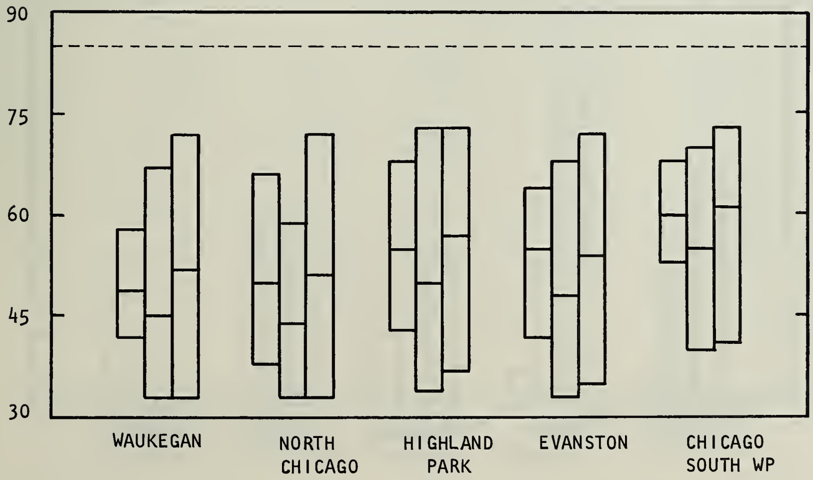


FIGURE 4. TEMPERATURE MEASUREMENTS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Degrees Fahrenheit)



(See page 71 for legend)

FIGURE 5. pH LEVELS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(pH units)

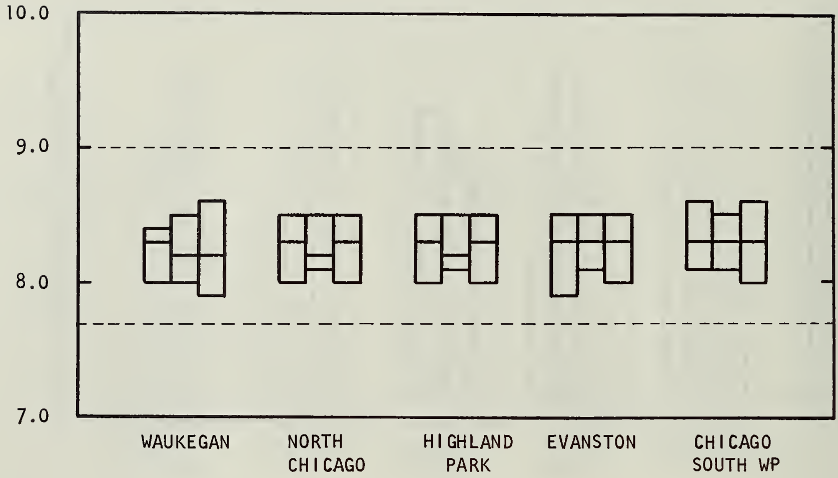
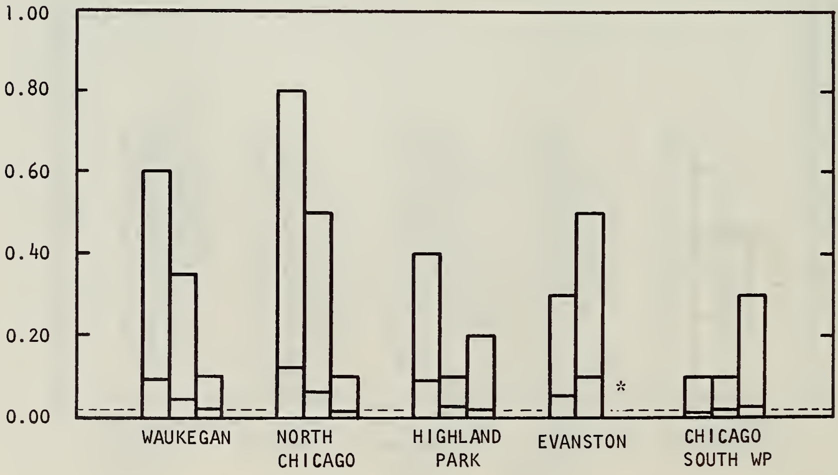


FIGURE 6. AMMONIA NITROGEN CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Milligrams per liter)



*Measurable amounts not recorded in 1970.

(See page 74 for legend)

FIGURE 7. MBAS CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Milligrams per liter)

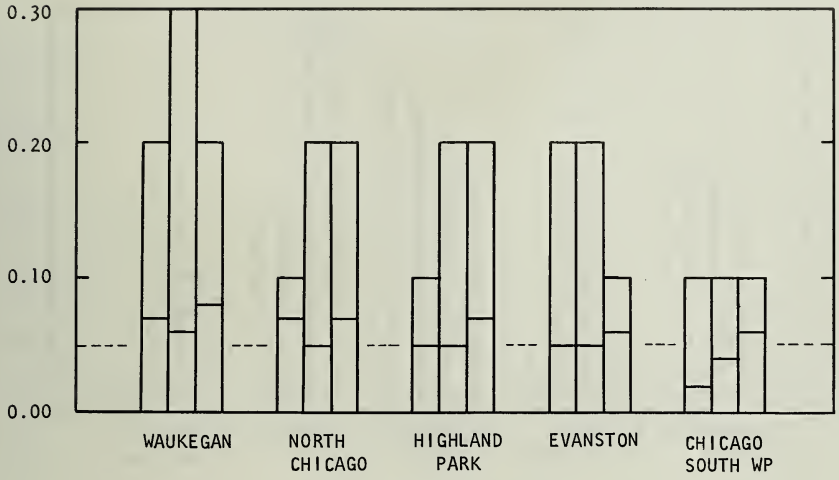
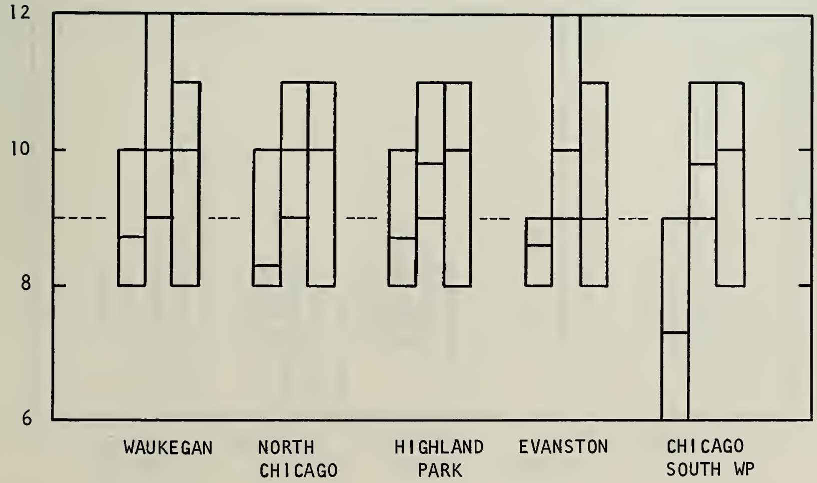


FIGURE 8. CHLORIDE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Milligrams per liter)



(See page 71 for legend)

FIGURE 9. DISSOLVED IRON CONCENTRATION IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Milligrams per liter)

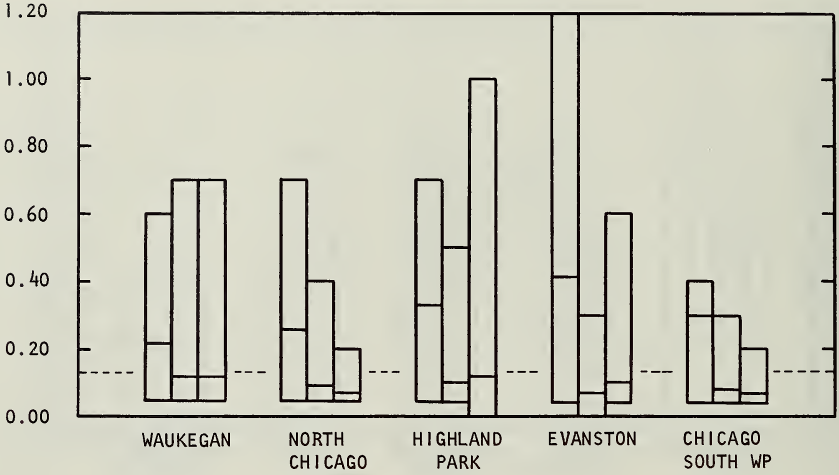
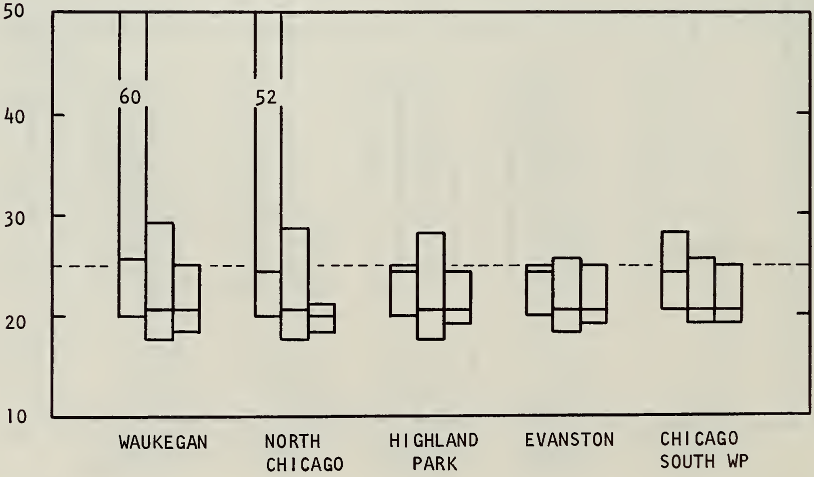


FIGURE 10. SULFATE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Milligrams per liter)



(See page 71 for legend)

FIGURE 11. TOTAL PHOSPHATE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Milligrams per liter)

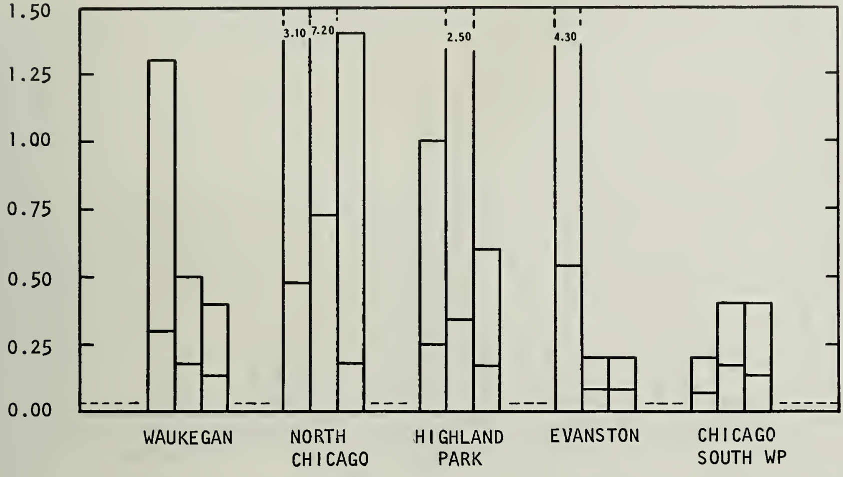
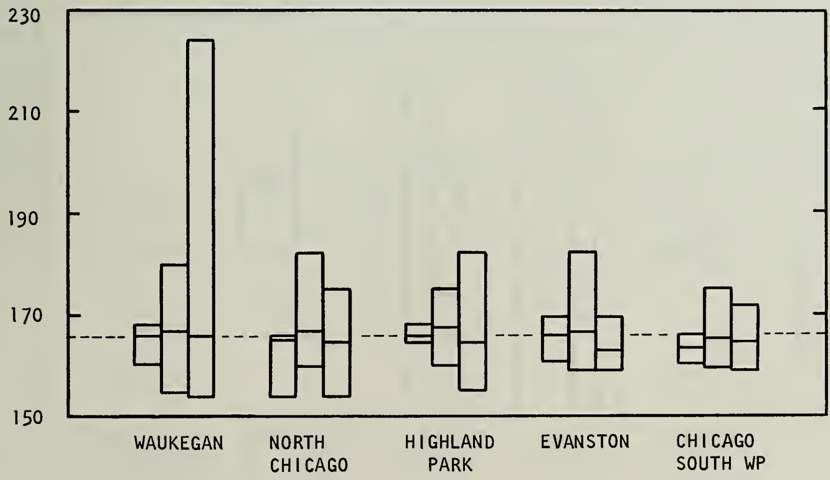


FIGURE 12. FILTRABLE RESIDUE CONCENTRATIONS IN LAKE MICHIGAN OPEN WATER, 1968-1970

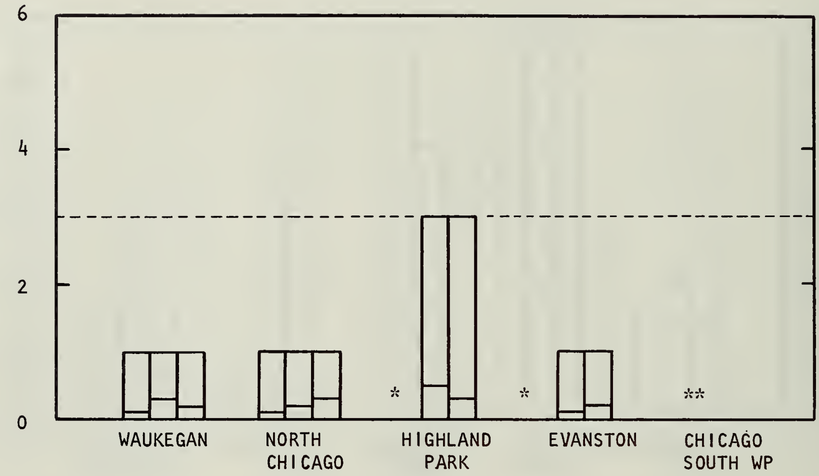
(Milligrams per liter)



(See page 71 for legend)

FIGURE 13. GROSS ALPHA RADIATION LEVELS IN LAKE MICHIGAN OPEN WATER, 1968-1970

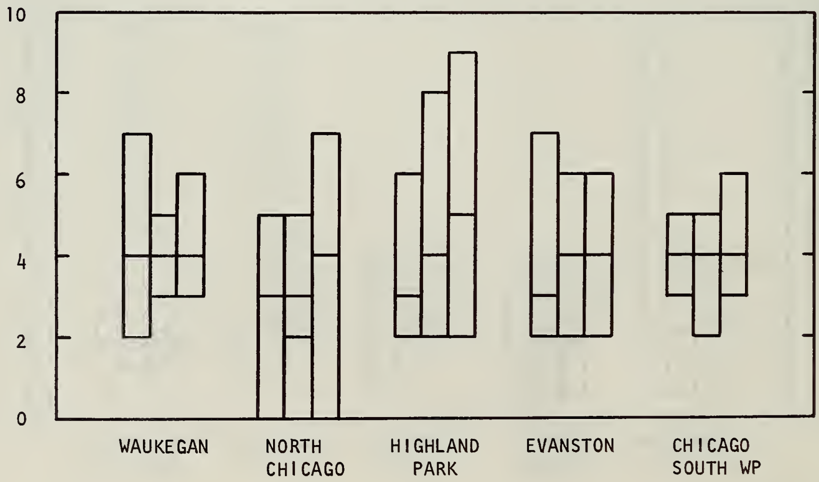
(Picocuries per liter)



*Measurable amounts of alpha radiation were not recorded in 1968
**Measurable amounts of alpha radiation were not recorded in 1968-1970

FIGURE 14. GROSS BETA RADIATION LEVELS IN LAKE MICHIGAN OPEN WATER, 1968-1970

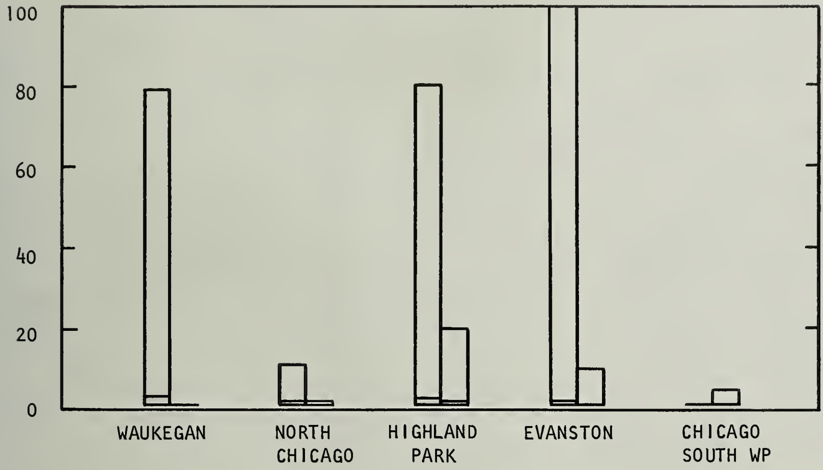
(Picocuries per liter)



(See page 71 for legend)

FIGURE 15. FECAL COLIFORM COUNTS IN LAKE MICHIGAN OPEN WATER, 1969-1970*

(Number of bacteria per 100 milliliters)



*Data available for 1969-1970 only

FIGURE 16. PLANKTON DENSITY IN LAKE MICHIGAN OPEN WATER, 1968-1970

(Numbers of organisms per milliliter)

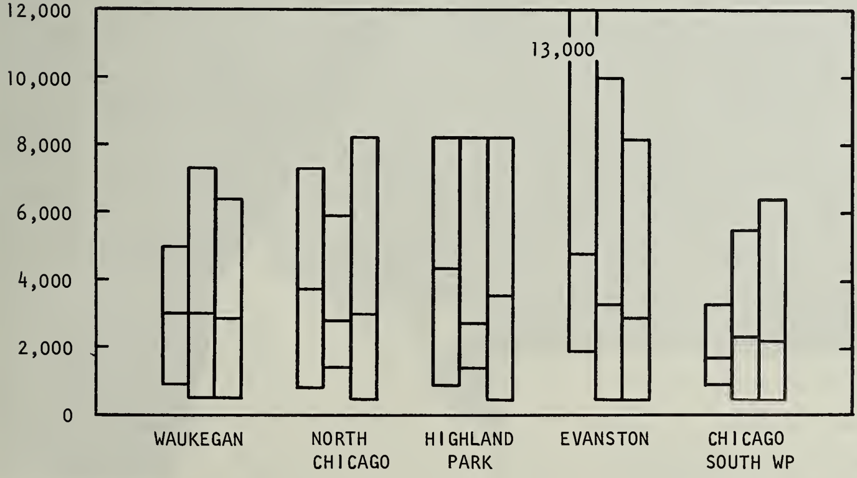


FIGURE 17 Locations of industrial and municipal waste discharges and sample stations between the Wisconsin Illinois State Line and Evanston, Illinois.

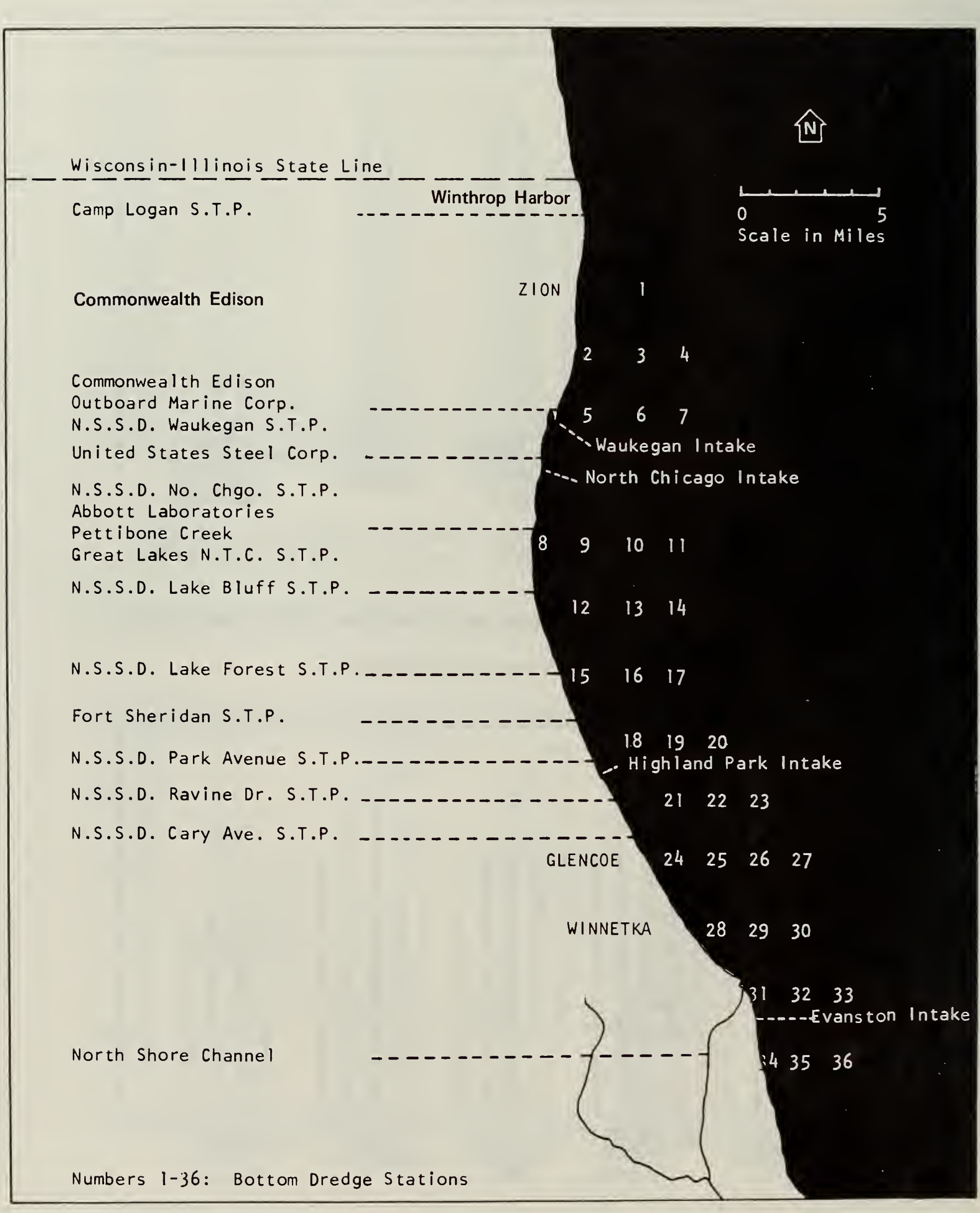


Figure 18 Locations of sample stations, in the Chicago area.

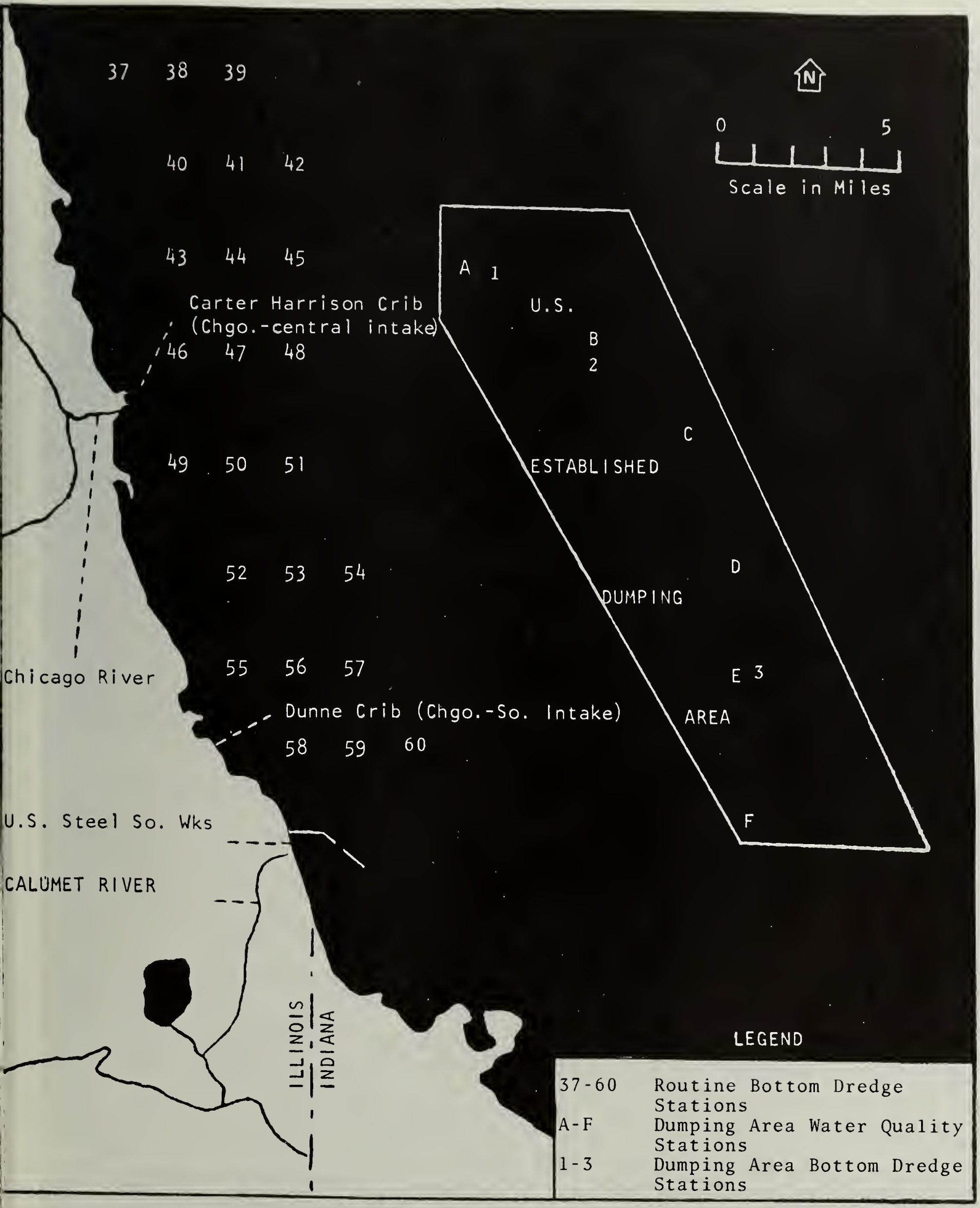


Figure 19 Locations of dredge samples collected off the Commonwealth Edison plant at Zion, Illinois.

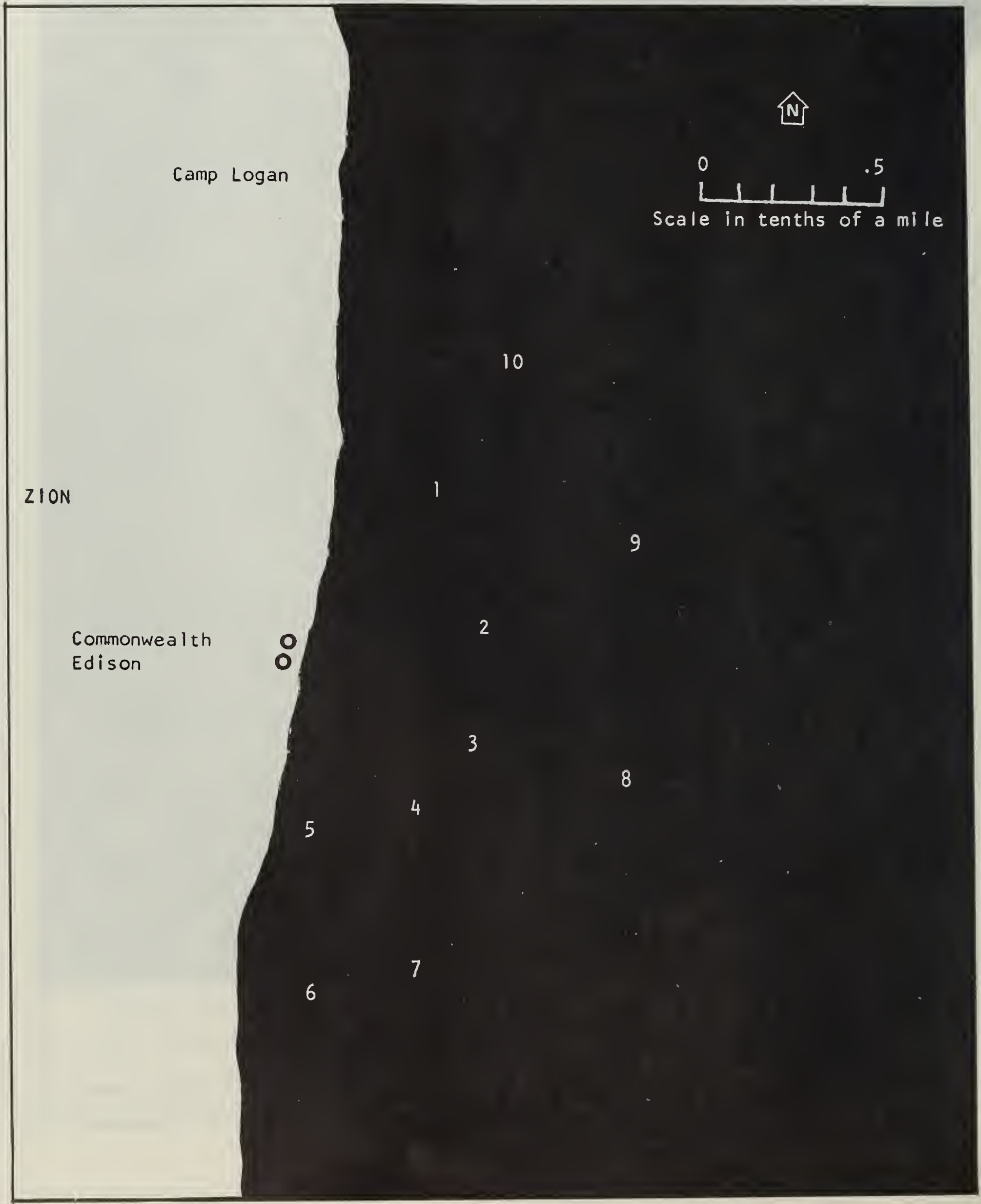


FIGURE 20 Locations of dredge samples collected off the Commonwealth Edison plant at Waukegan, Illinois.

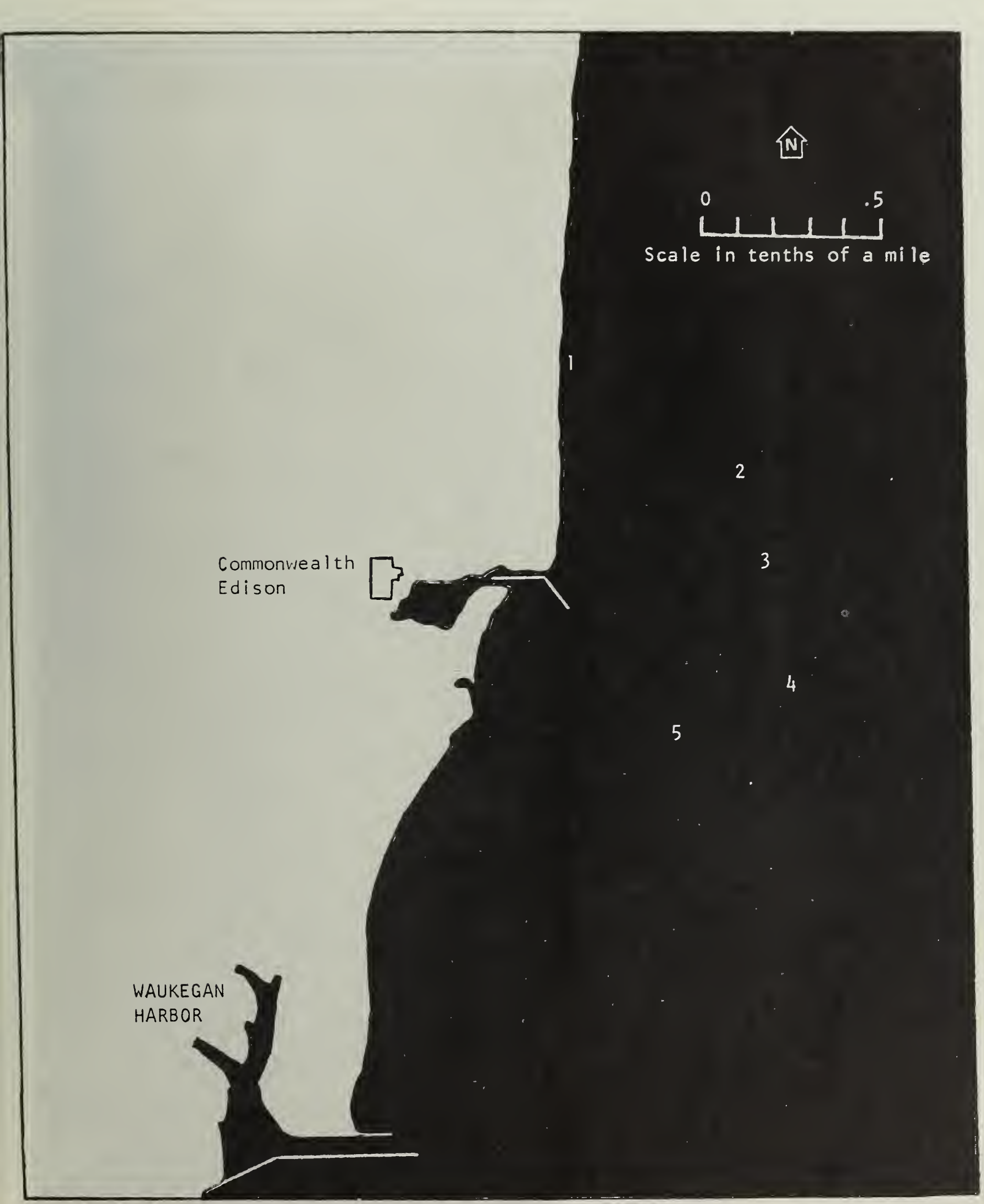


Figure 21 Locations of dredge samples collected off the U.S. Steel plant (Waukegan), the N.S.S.D. sewage treatment plant (North Chicago), and Abbott Laboratory (North Chicago).

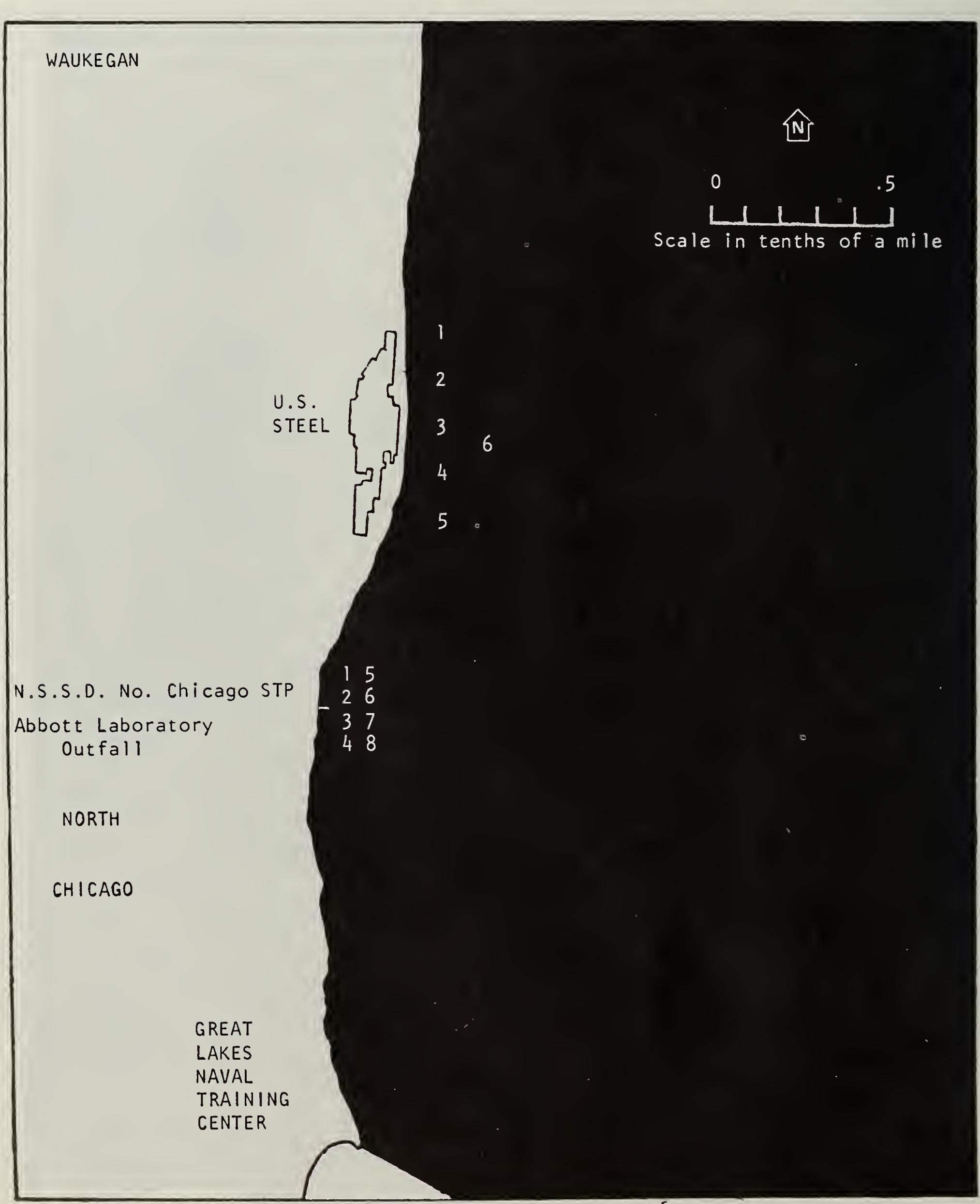

WAUKEGAN
N
0
.5
Scale in tenths of a mile
U.S. STEEL
1
2
3
4
5
6
N.S.S.D. No. Chicago STP
Abbott Laboratory Outfall
1 5
2 6
3 7
4 8
NORTH
CHICAGO
GREAT LAKES NAVAL TRAINING CENTER

Figure 22 Location of dredge samples collected off the Lincoln Park Gun Club in Chicago.

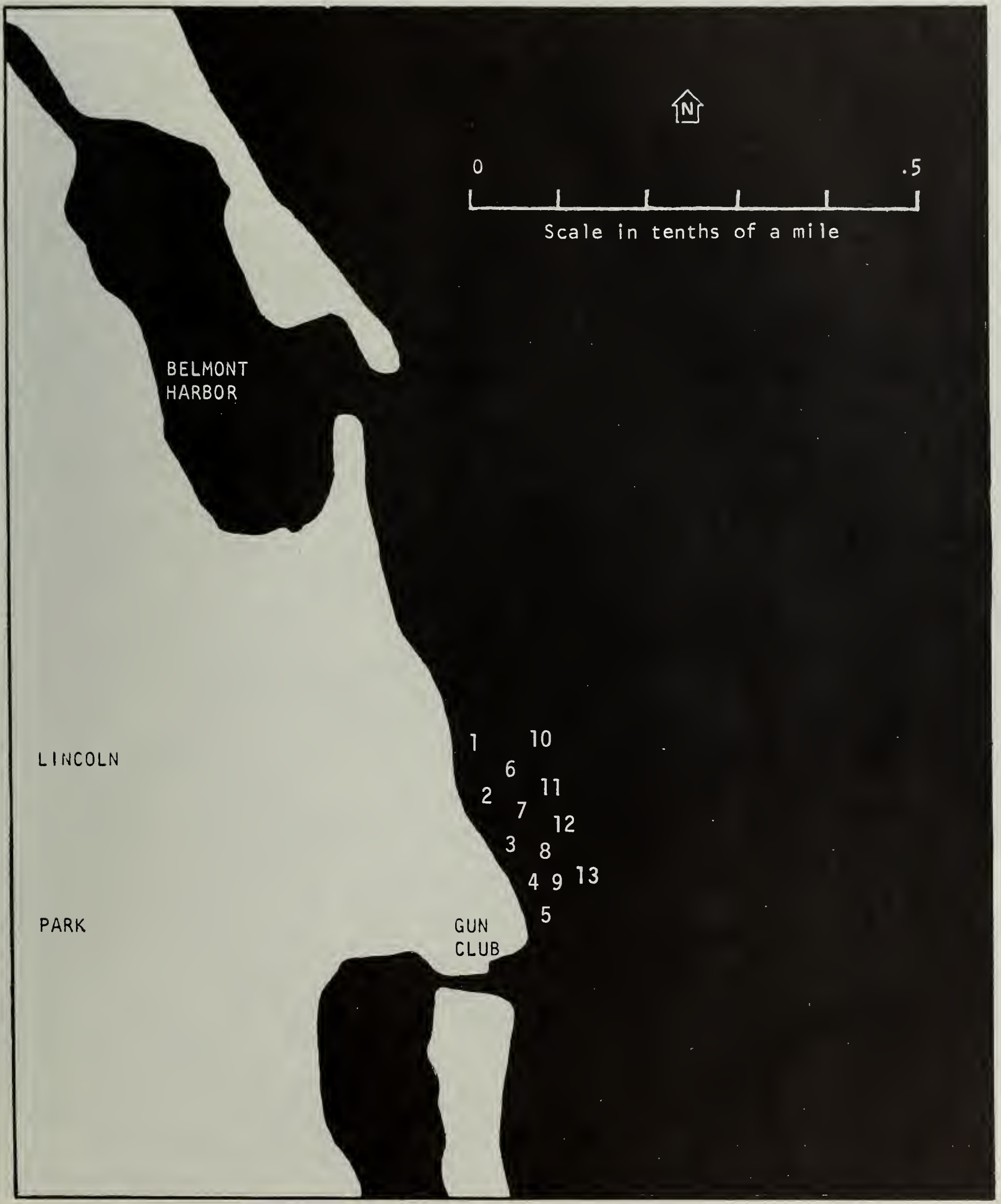


FIGURE 23 Locations of water quality and dredge sample collection in the Calumet Harbor area off Chicago.

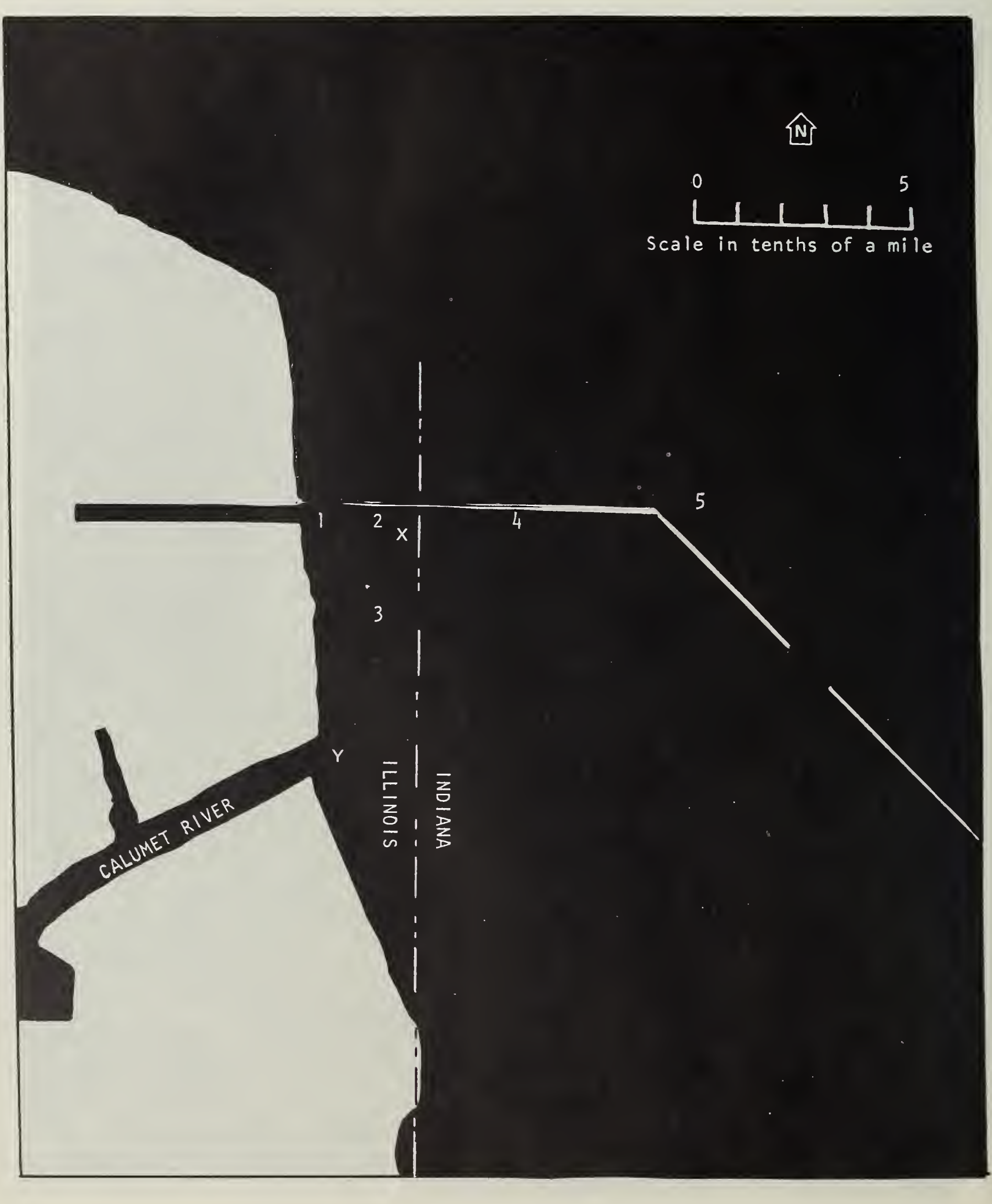
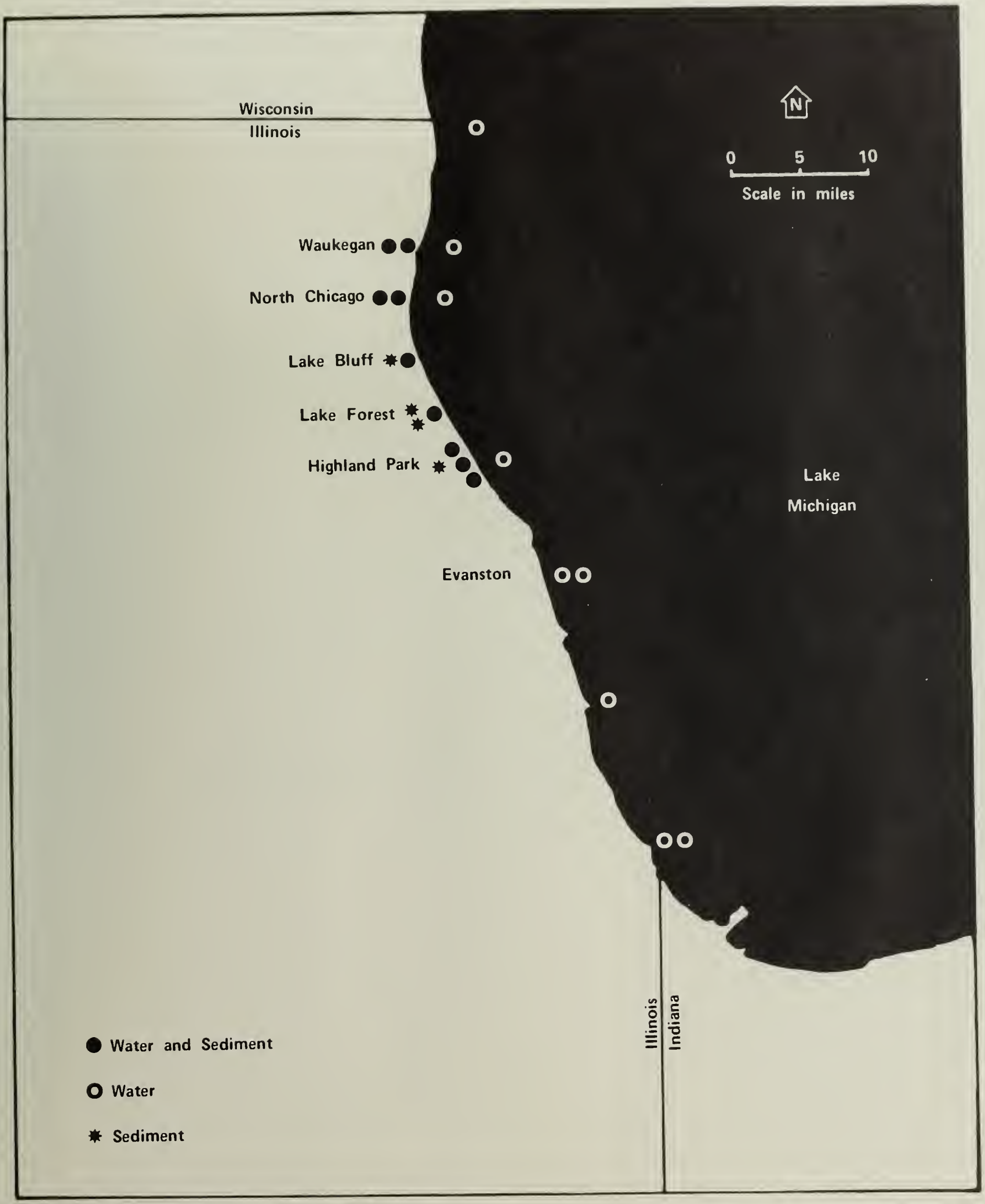


Figure 24 Locations of samples collected for pesticide analysis.



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